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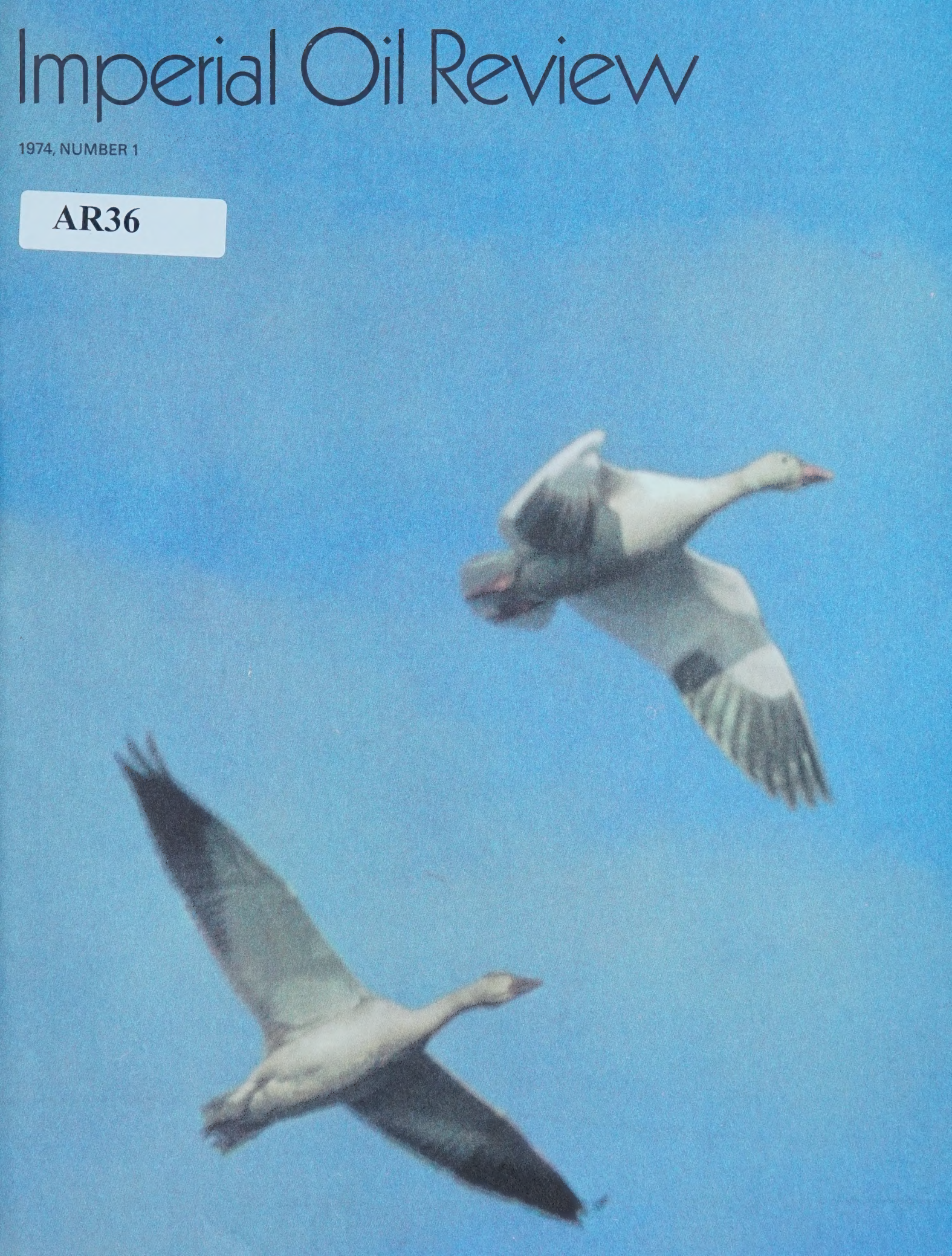


Chris Bruun/Imperial Oil Limited

Cold Lake

There's a deposit of thick oil in Alberta, holding 160 billion barrels. The trouble is, until recently it has been too gummy to get out of the ground

by Steve Lynett

Provincial highway 28 leaves Edmonton in a gentle northeastward arc that leads to the shores of Cold Lake, 180 miles away. To a casual eye, the surrounding region is typical of Alberta's rural northland – a gently undulating blanket of birch, poplar and spruce punctuated by numerous lakes. But 1,600 feet below ground surface lies one of the largest oil deposits in Canada, and oilmen would like to recover the billions of barrels stored in the Cold Lake deposit.

But Cold Lake crude, a naturally-occurring hydrocarbon, is simply too thick to be recovered by conventional methods. Dumped on the ground, a barrel of it would hardly flow at all. In a test with a conventional oil well, little more than one barrel of the gummy liquid would come to the surface.

And so, in the last 10 years, Imperial Oil has spent about $17 million testing the Cold Lake deposit to find an economical method to bring out the oil. Researchers have found that steam, injected into the oil zone, will thin out some of the crude so that it can be pumped to the surface. Over the last two years a pilot project of 23 wells has been producing as much as 1,500 barrels of crude oil every day. In August, 1973, Imperial announced plans for an enlarged pilot test that would nearly triple the present output – a step to obtain more data and lead the company closer to establishing a large-scale, commercial plant which would probably be capable of producing about 100,000 barrels per day.

Production and steam injection lines linking wells to a central utility site create a snowflake pattern at Cold Lake in Alberta.

The Cold Lake reservoir, like the famous Athabasca tar sands 160 miles to the north of it, is one of several oil-rich sand deposits in northeastern Alberta. The Energy Resources Conservation Board of Alberta estimates the oil in place for all the heavy oil sands to be approximately 900 billion barrels. On its own, Cold Lake is thought to contain some 160 billion barrels of that total but not all of it will be recoverable. Imperial engineers hope that currently-developing technology will bring out at least 30 billion barrels. Only a fraction? Perhaps, but an impressive amount when compared to Canada's 10-billion-barrel reserve of recoverable conventional crude oil.

With the currently-producing tar sands of Athabasca, Cold Lake will help meet Canada's future crude oil needs. But recovery of the highly-viscous Cold Lake oil depends on a number of factors, both economic and technical.

For one thing, the heavy oil is more difficult to recover, and the costs are higher. This means that until crude oil prices rise they will not be sufficient to cover the higher production costs. In the past the price of crude oil has been too low to permit a costly development like Cold Lake.

During the 1960s the world's capacity

to produce crude oil was greater than its need. As a result, there was strong competition among oil companies looking for markets and this kept the price down. But by the start of this decade the situation had altered. Higher standards of living caused oil demand to rise rapidly because oil was the cheapest source of energy. At the same time, the growth in other energy sources was curtailed by various restrictions. Coal became subject to stringent sulfur emission standards, hydro was limited to sites that could be developed economically, and nuclear power development was slowed down by a combination of adverse public reaction and plant construction problems. Expanding industry, population increases and environmental pressures combined to increase the demand for oil and, as a result, world prices have begun to rise. Now, with higher prices, developments like Cold Lake are more likely to be undertaken.

'Cold Lake is not a bonanza but rather an additional source of crude,' says John Nicholls, Imperial's area superintendent of Cold Lake operations. 'It can't compete with conventional crude and can only be produced at higher crude prices.' But, if increases in the price of crude and sufficient markets can be assumed, the technology to produce Cold Lake remains the only major hurdle.

When it first became evident that Cold Lake was an important source of oil, the region attracted the interest of a number of oil companies who saw its potential for large future oil production. By 1964, five companies had begun to set up experimental projects to bring out the oil. By the end of 1972, at least 10 companies had made an effort to develop an economical operation. But in 1973, Imperial was the only company still carrying out a field pilot program to discover the secrets of producing the heavy oil at Cold Lake.

In the early years of the test development, Imperial went into Cold Lake with equipment and crews to investigate the lease lands that had been acquired. First efforts were directed at finding the oil zone and outlining its size. A number of exploration wells were drilled and in each case the core sample brought up

Chris Bruun/Imperial Oil Limited

Imperial's Cold Lake project produces 1,500 barrels of oil per day, heated by steam from the boilers at the right to make it flow

rich oil sand.

'As a result of the drilling, we knew we had a lot of oil down there,' recalls John Nicholls, 'but we weren't sure just how we could recover it successfully.'

Various methods have been tried to thin out the heavy oil at Cold Lake. Among the possible methods are steam injection, controlled underground fires and the use of thinners such as diesel oil. For Imperial, steam injection appears to hold the most promise. Alvin Winestock, a senior engineering specialist on the Cold Lake project, explains: 'Steam seems to be the best method of recovery from the standpoint of both efficiency and economics. We've decided to stick with it and we feel that it's the right move.'

The steam, at 600 degrees Fahrenheit, is driven into the oil zone for about a month at a pressure of 1,600 pounds per square inch. There it heats the oil – which reduces its viscosity – and provides additional pressure to drive the liquid to the well bore. Then a mixture of oil, water and gas is pumped out of the wells for about three months or until the amount of oil recovered is too small to continue. Then the cycle is repeated. This operation of pumping steam in and pumping oil out has been nicknamed 'huff and puff'.

During the first four years of field experiments at Cold Lake, a small number of wells were drilled and a portable generator produced the steam. In 1967, the first pilot project was expanded. At this pilot, christened Ethel after nearby Ethel Lake, a four-generator steam plant was erected to power the wells, as well as three of the old wells that were still producing. Each of the generators, about the size of a railway boxcar, is capable of producing 43 million British thermal units of heat per hour; the four of them produce enough steam to heat all the houses in a city the size of Red Deer, Alta. Facilities were erected for separation of the oil and water and a loading rack was built so that the oil recovered from the pilot could be trucked away. All the additional structures, including a prefabricated office unit, are located on the crest of a hill overlooking the valley where the injection wells now are steaming and producing.

This pilot provided enough data for engineers to evaluate some of the effects of steam injection. 'What followed,' ex-

Nodding 'horsehead' pump lifts the oil to the surface after steam has been injected for a period sufficient to thin the heavy oil in the reservoir

Steam for the Cold Lake project comes from these four generators. A new pilot plant with a capacity of 4,000 barrels per day is being built

plains Winestock, 'was the nearby May pilot with 23 wells about 500 feet apart – about five acres per well. To build the May we took the first pilot results and our best ideas and combined them.'

Equipment began drilling the May pilot, named for May Lake, in the fall of 1971 on a 100-acre site from which only enough brush was cleared to provide working space around each of the wells. 'Most of the wells were started on steam injection during the coldest part of the winter,' says Winestock, 'and that was really tough work.' This pilot is still operating and is being run by 14 people, most of them residents of the town of Grand Centre, located on Highway 28 about 16 miles southeast of the test site.

In the fall of 1973, construction crews from the Cold Lake area had completed clearing for the new $12 million, 56-well test on a tract of land approximately four miles from the May site. On this site, named Leming, for the lake nearby, a new set of facilities will be installed including larger steam-producing and oil-water separation facilities as well as a more efficient truck-loading unit. When it comes into full production, the new pilot will be producing as much as 4,000 barrels of heavy oil per day. Its output will be used for asphalt and transformer oil production at Imperial's new Strathcona refinery at Edmonton. The Leming pilot is expected to show what the Cold Lake wells can produce on a sustained basis. 'Both the May and Leming pilots,' John Nicholls said, 'will permit a realistic judgment of the risks involved in making a future very large investment. This step-by-step development will give us a better understanding of the problems and the results we can expect.'

'We are confident that through continued improvements in producing technology and rising crude oil prices, Cold Lake will become a significant supply source in the future,' says Bob Peterson, operations manager, Cold Lake. But what's it like to be part of a project that holds such importance? Says Alvin Winestock: 'It's a great project for technical people because of the room for innovation. There can be a lot of problems and frustrations, but there is also great satisfaction from coming up with the right answer.' □

Will success spoil the snow goose?

Conservation practices have brought this species back from the brink of extinction. Now, the problem is how to manage the surplus

The world's population of greater snow geese is easy to keep track of. Every May and every October, most of it arrives in loud ragged Vs at the Cap Tourmente National Wildlife Area, 30 miles east of Quebec City. This year, biologists estimate 150,000 birds will make the twice-yearly visit to the 5,000-acre sanctuary.

But in 1906, when the count was taken, there were only 3,000. The big white birds with the black-tipped wings seemed ready to follow the passenger pigeon into extinction.

The birds have made a comeback, and they owe their survival to hunters.

Sportsmen had been coming to Cap Tourmente for years before 1906 to harvest the birds. The dwindling flocks saddened them, but no one else seemed to be interested. So, in 1908, they took on the job of saving the species themselves. Seven private hunting clubs leased the land that made up the birds' staging area at Cap Tourmente. They worked to preserve the habitat; they put strict controls on their own hunting.

Because of these efforts, the greater snow goose population grew to about 10,000 birds by 1931.

In that year the U.S. government joined the hunters in their fight to preserve the geese. Hunting the birds was banned in their winter range along the Carolina marshes and the population of greater snow geese grew more quickly.

In 1969, there were 65,000 birds in the flock. In that year the Canadian gov-

by Douglas Scott/photos by Barry Ranford

ernment took Cap Tourmente over from the hunting clubs and made it a national wildlife area. In announcing this move, The Honourable Jean Chrétien paid public tribute to the hunters for the part they had played in saving the snow goose.

With the establishment of the national wildlife area, the government began a long-range plan for the species. Biologists began probing the ecology of the Cap Tourmente forest, coastal plains and marshes. Other scientists worked to determine an adequate breeding population for the birds.

The first government studies were completed in 1972. They showed the greater snow goose was in no danger of early extinction. In fact, by May of 1972 their population had almost doubled: there were now an estimated 122,000 birds. Where the problem had once been too few birds for the species to survive, now there was real danger of there being too many.

One of the main reasons the birds have always come to Cap Tourmente is a grass-like water sedge that is plentiful in the marshes there; the geese feed off its lower stem and roots. But by 1972 there was an alarming decrease in the quantity of the plant.

It wasn't hard to understand. Because of the hunting ban, more and more birds were taking refuge in the wildlife area, and the sedge crop simply wasn't big enough to feed them all. A growing number of the birds had to go elsewhere for food, and this created another problem: the greater snow geese were beginning to compete for forage with the wildlife that normally inhabit the salt-water, cord-grass marshes of the lower St. Lawrence. A once-threatened species was now a threat to the habitat of other species.

The government made a decision. Hunters had worked to solve the snow goose population problem in 1908; hunters could help to solve the snow goose population problem in 1972. The annual hunt at Cap Tourmente was reintroduced. Drawing on the hunting clubs' 60 years of experience in the area, the National Wildlife Service set up a controlled hunt that's unique in North America.

Advertisements inviting applications

Dwarfed by the immensity of the marsh, a lone hunter stands up for a better bead on a flock of geese farther out

To reach the blinds on the soggy marshes, the hunters ride out on a mud sleigh driven by a guide (above), who also sets out the decoys (below). The buildings in the background—once a seminary—now provide offices for the wildlife service

Hunting stops on weekends to permit visitors at the wildlife centre to watch the undisturbed birds feeding on the marshes

for the hunt are placed in newspapers in Quebec, Ontario and New Brunswick. In 1972, the ads attracted 1,610 applicants; in 1973 that number climbed to 1,880. Applications are open to residents of Canada only, and 300 successful applicants are selected by a computer lottery.

Each successful applicant is allowed to bring a single hunting companion, who must also be a Canadian resident. They're assigned a 24-hour shooting period, running from noon one day until noon the next.

The hunting parties shoot from water-tight wooden pit blinds, constructed along the inter-tidal marsh by the old hunting clubs and now maintained by the government. In 1972, each party was limited to a single blind for the entire hunt, but in 1973 they were permitted to draw two blinds each and to split their time between the two locations. There are 30 blinds in all, and they're located a minimum of 300 yards apart so that hunting parties don't interfere with each other.

Former employees of the hunting clubs act as guides, and every hunting party is required to hire one. They take the hunters out to the blinds in horse-drawn mud sleighs, put out the 20 wooden goose decoys supplied by the National Wildlife Service, and help recover downed birds.

On each of the two days the hunter is out, he's permitted to take five geese, six ducks and 10 snipe. For the privilege he pays $15 for the special Cap Tourmente hunting permit, $2 for a federal hunting permit, either $4.25 or $17.50 for a Quebec hunting permit (the higher price is charged people who are not residents of Quebec), and a $10 fee for the guide.

The National Wildlife Service estimates that each hunter spends a total of $122.25, which includes things like transportation, lodging and food.

What does he get for his money? In 1972, the average hunter brought down 1.3 geese and 0.9 ducks. The wildlife service figured each recovered goose cost $93.62. Yet the shooters are happy. Following the 1972 hunt, 92 per cent of hunters responding to a questionnaire said they'd found the hunt satisfactory, despite the low take.

The low kill in 1972 is explained by Marcel Laperle, the man who runs Cap Tourmente for the federal government. 'It was a very poor breeding year. That meant there were very few juvenile birds to be taken, and juveniles normally make up the majority of the kill. We had to shorten the hunt, too, because the weather turned bad and, with ice forming on the St. Lawrence, the geese left early.'

The early closing of the 1972 hunt meant that only 448 of the 600 hunters entitled to shoot actually took part in the hunt. Only 526 greater snow geese were harvested.

The 1973 hunt has been more successful. In the first four weeks alone 2,700 greater snow geese were taken. But, as Laperle points out, that won't have much effect on the problem of over-population.

'Hunting in Canada alone won't reverse the population trends, or even slow the growth much. But we think we've succeeded in our immediate objective. Because of the hunt, the birds are no longer concentrating in the wildlife area in such overwhelming numbers, so there's far less danger of their exhausting the habitat here.'

'Stem counts' of the water sedge in 1973 bear out this optimistic view. The sedge is growing again, and that's crucial to preserving the Cap Tourmente environment.

'We'll maintain the hunting pressure here to preserve the marshes,' Laperle explains, 'but we don't pretend it's any solution to the long-run question of over-population.'

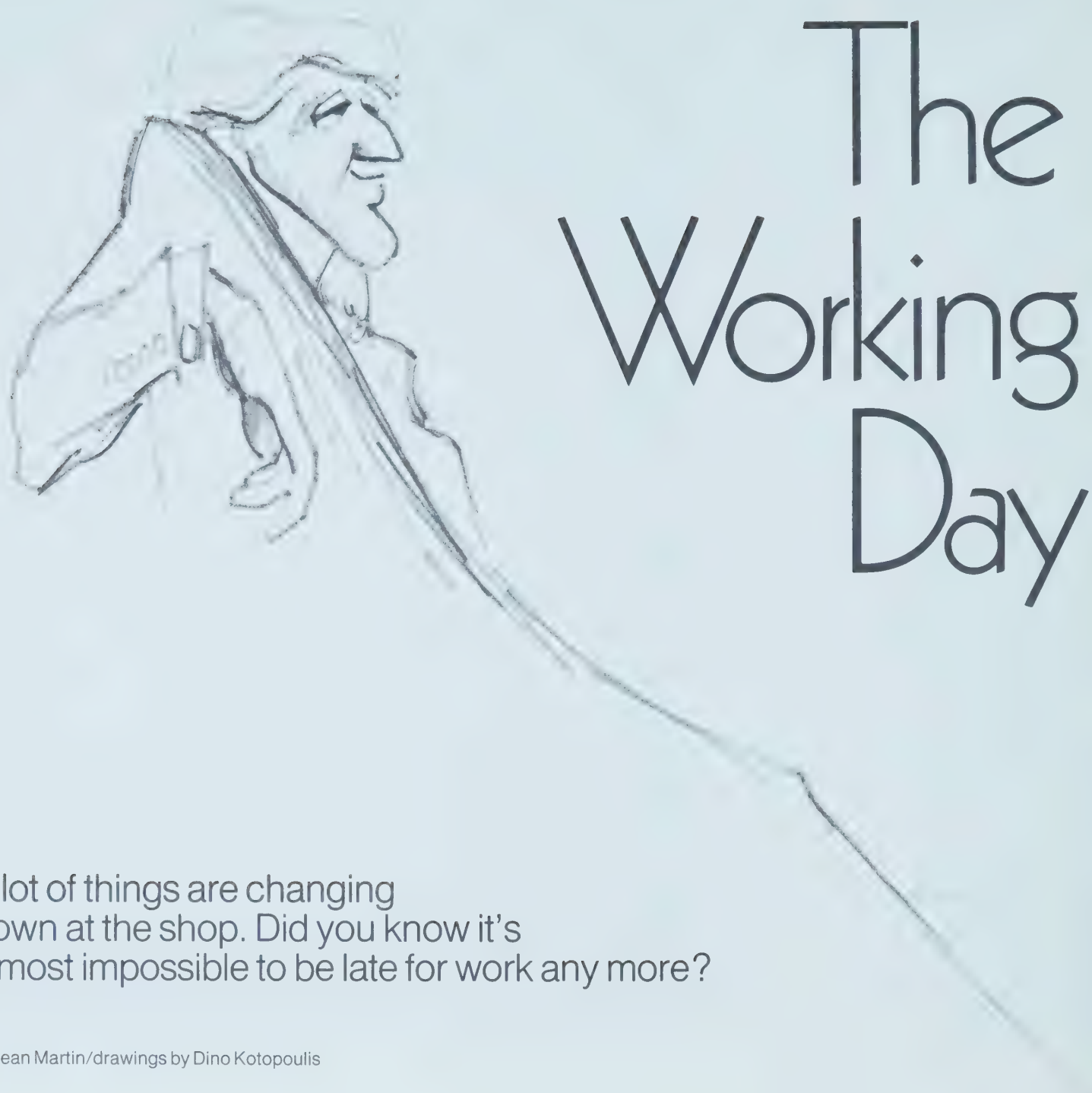
As their numbers grow, the birds are expanding their range, not only in Canada, but along the marshes of the eastern United States where they winter. That kind of expansion worries ecologists like Marcel Laperle.

'Whenever a species moves into areas it has not traditionally used, there's a danger of an imbalance being created. It may compete there with other species – endangering their survival – or the different environment may cause it to change its habits in a way that can do harm in the long run.'

One solution to the greater snow goose population explosion might be for the United States to lift its 42-year-old ban on hunting, at least within government-supervised sanctuaries where controlled hunts can be organized. But the Canadian hunt is helping to preserve the delicate balance of the Cap Tourmente marshes.

And of course, Cap Tourmente is more than a hunting ground. Even during the hunt period, all shooting is suspended from noon Saturday until noon Monday, so that the thousands of tourists who visit the sanctuary can view the huge flocks of geese without disturbance. In 1972, the federal government opened a new wildlife centre at Cap Tourmente, to instruct the non-hunting visitors to the wildlife area on the delicate relationship between the big birds and their historical staging grounds. □

The greater snow goose: white with black wing-tips, six to 10 pounds



The Working Day

A lot of things are changing down at the shop. Did you know it's almost impossible to be late for work any more?

by Jean Martin/drawings by Dino Kotopoulis

To anyone who ever slept through the alarm clock, missed the morning bus, was ticked off for being late to work, or who yearned to knock off and see a movie in mid-afternoon, a certain 110 Imperial Oil employees seem to be living in the working stiff's paradise.

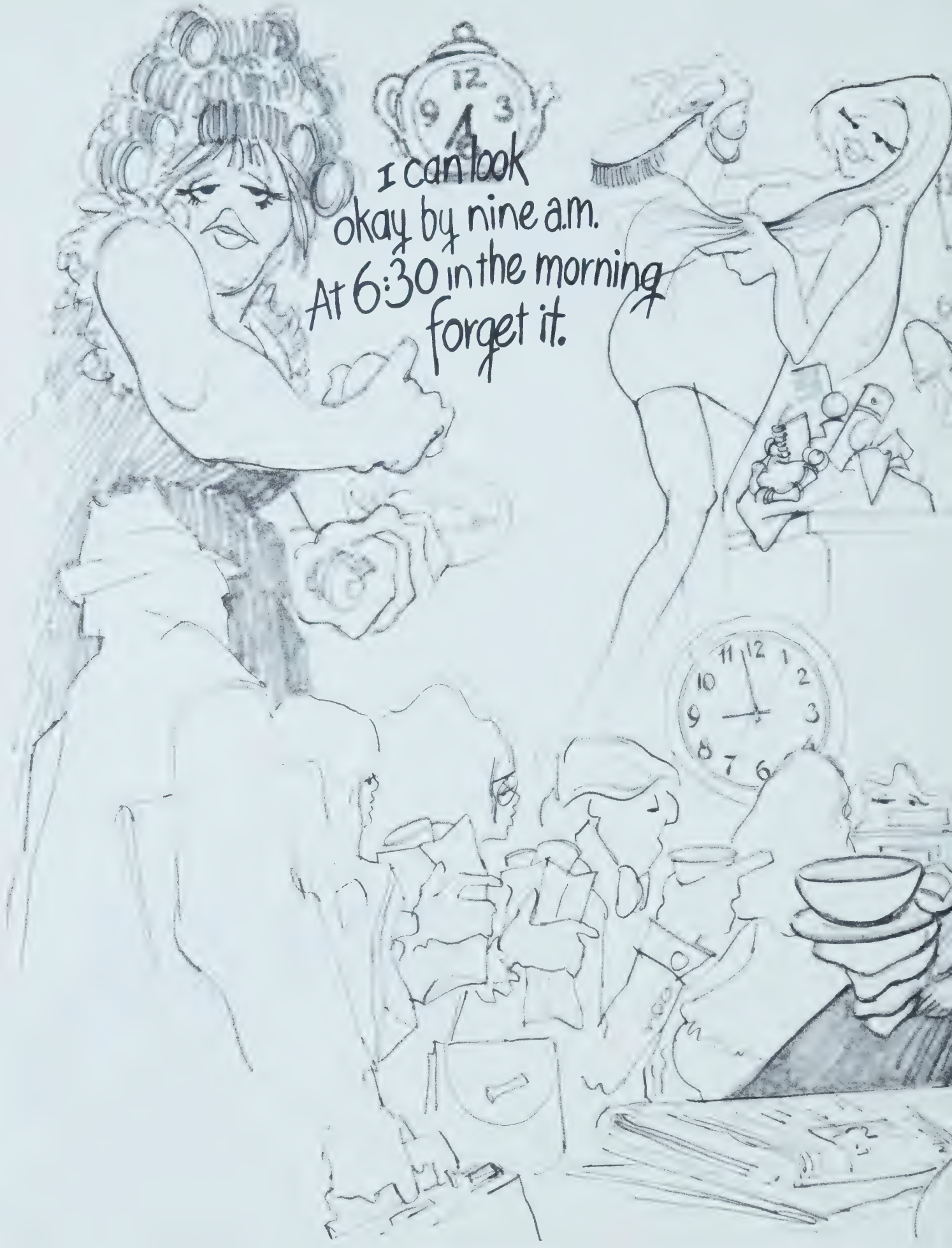
Some of them begin their jobs in the systems and computer services division of the Toronto head office at 7:30 a.m. and quit at 3:30 p.m. Others choose to start at 10 a.m. and work until six. Still others, on particularly trying days, just work from 10 a.m. to 3:30 p.m. and make up the missing hours later in the week.

They're all on flexible hours–a new kind of working day, as malleable as fun-dough, devised for people who hate regimentation in their jobs. In similar situations all over the western world, individuals are demanding and getting a personal say in how, when and where they work. It is part of a vast but quiet revolution: the liberation of the working person, be he or she a stenographer, executive, technician or laborer. And its effects on society will be as far-reaching as was the advent of trade unionism.

What's happening to the working day is part of a fundamental change in attitudes toward work and life.

'The work ethic is not dead,' John A. Paré, a Montreal consultant on business organization, told a September annual meeting of the Canadian Chamber of Commerce. 'It just isn't very well.'

'The man whose father felt lucky to have a job in the 1930s now feels that his own job should be challenging as well as economically rewarding,' points out Imperial President J.A. Armstrong.


I can look
okay by nine a.m.
At 6:30 in the morning
forget it.

'And his son *demands* this.'

It doesn't necessarily mean that people today prefer idleness or leisure to daily occupation, Armstrong adds. No matter how much we grumble about it, most of us like to work. Otherwise, why do some 'moonlight' on a second job? And why have so many married women with families entered the work force, when taxation and the high cost of child care and transportation, have removed much of the economic incentive for returning to work? 'It's just that they expect more from their jobs than they used to,' Armstrong says. 'And they feel more free to demand it from the companies that employ them.'

Armstrong calls it a 'crisis of identity'– the frustration, bewilderment and sheer anger that individuals feel when society seems to ignore their needs and smother their individuality. When a person is dwarfed by huge institutions, sees his hard-earned formal education becoming obsolete, and watches his future being shaped by strangers, he feels impotent and resentful.

That's why a sharply questioning, critical attitude is showing up among employees and potential employees, beginning with the first job interviews. New employees used to be almost passive, says Bert Dickie of Imperial's employee relations department. 'Now they want to know about their long-range prospects–and not just salary but the avenues to advancement.'

John English of The Hudson's Bay Company, and Gary Webb, personnel manager for North American Life Assurance Company, find the same hard-nosed stance, not only during recruitment but through the employees' careers. Once, in most companies, if a man were offered a move he took it. Turning it down might not have got him fired but usually meant that chances of future promotion were almost nil. Not any more.

'People turn down promotions all the time, and for non-economic reasons,' says English of The Bay. 'Maybe the kids are happy in the present school, or the wife is holding a job she loves. So, if a man is promotable and turns down a move to one city, we're likely to offer him an alternative, or we'll try to bring him ahead where he is.'

Imperial finds similar situations where, for instance, employees show an increasing reluctance to move to Toron-

to. They're cool toward its higher cost of living and its urban clutter, even though chances for rapid advancement might be better in head office, and they are not faulted for preferring smaller cities.

Coupled with this new insistence on personal values is a greater willingness to change employers. A quarter century ago employees might spend their entire working lives with the same firm, perhaps partly through insecurity and partly through loyalty. Today's company man is, above all, loyal to himself and his career. A systems analyst or engineer regards himself primarily as a member of that profession rather than an employee of Imperial or The Bay.

'Ten years ago employees rarely moved between, say, Eaton's and The Bay,' says John English. 'Today they move in pretty significant numbers.'

Yet a stable productive employee is as essential to business as always. The trick, then, is to keep him or her happy–and hence the new freedoms.

The most obvious and dramatic change is in the working day. Flexible hours isn't a new concept at Imperial. The company was one of the first in Canada to guarantee all employees two full days off every week (causing company wits to suggest that the corporate symbol, ESSO, stood for 'every Saturday and Sunday off'). For years, drilling and geological crews have worked long hours and consecutive days in the field, storing up time to be used as consecutive days of holiday on their regular trips home. In 1966, a number of company truck drivers arranged to work their 40 hours per week in the form of four days of 10 hours each.

Then in 1969, 59 employees of the company's Winnipeg refinery suggested that their five-day 40-hour week be transformed into a three-day week based on 12-hour shifts. Imperial agreed. Its rule of thumb: try any such idea if a majority of employees support it and if it will result in no lost productivity or increased costs.

In Winnipeg the average number of hours per work week dropped from 40 to 38.8 with a corresponding reduction in pay. But in other Imperial plants, variations on the pattern have *increased* the weekly work hours from 40 to 42.

'The important thing,' says company President Armstrong, 'is that the thrust of employee interest has centered not so much on working fewer hours as on having more control over the pattern of the work week itself.'

The latest, most intriguing experiment is flexible hours. Different companies have their own variations, but any flexible hours system starts by defining the total number of hours of operation for the day, known as the 'band width'. For Imperial's head office systems and computer services employees, who went on flexible hours in December, 1972, the band width is 7:30 a.m. to 6 p.m.

Next, the 'core hours'–hours of peak activity when all employees must be at work–are defined. In the Imperial experiment, these are 10 a.m. to 3:30 p.m. Everyone in systems and computers must be on hand during those hours, but they may make up the rest of their eight hours per day (less lunch time) by working the requisite number of hours within the band width on that day or on subsequent days. They must average the required number of hours per day over each pay period (every two weeks). Within those limits, they work at their own discretion.

Already widely used in Europe, flexible hours is being adopted by more and more Canadian firms. Gordon Harrison, a management consultant with Riddell, Stead and Associates Ltd., of Montreal has helped several companies set it up.

'People put in the same number of hours on flexible time,' he explains, 'and because they have a chance to express their preferences, they probably do even more work during those hours.'

In practice, about 75 per cent of such employees tend to set regular hours for themselves, most of the time. Harrison tells of one 30-years'-service man who continued to work nine to five, even though flexible hours offered him an option. Well, would he like his firm to go back to the old system, asked Harrison?

'I would *not!*' he snapped. 'I work nine to five because I like it–but I don't *have* to any more. Don't you understand how important that is?'

Even where the nature of company operations limits the options, employees still like flexible hours. At the Taylor Instrument Companies of Canada Limited, in Toronto, the 'core' is 9 a.m. to 4 p.m., while the 'band' is 8 a.m. to 5:15 p.m. in the office, 7:30 to 4:45 in the factory.

'But even if it only means that an employee stuck in traffic will still not be late for work, it has removed one area of possible friction,' says personnel manager Ross Ellis. 'And that helps improve morale.'

Flexible time is being tested in several departments of the federal government and has become permanent for several hundred Ottawa employees of external affairs. Their core is 9:30 to 3:30 and the band is 7 a.m. to 6 p.m. According to W.E. Bauer, director of staff relations, morale is higher, efficiency is greater and parking lots, elevators and cafeterias are less crowded. Employees keep track of their own hours on standardized forms, or by means of individual clock-like devices called time accumulators. And the times are verified by supervisors on a spot-check basis. Generally, say the supervisors, employees tend to work more rather than fewer of the necessary 37½ hours per week.

North American Life Assurance Company devised a different pattern. It offers staggered hours, so that any employee may choose to start an hour earlier or an hour later, and work a standard eight hour day, less lunch time. But through additional options, NA staffers may work an extra 45 minutes per day and take every fifth half-day off, or every tenth full day off.

'About 40 per cent of the work force has exercised the options,' reports Gary Webb. 'They all seem to appreciate the opportunity for choice. And there are surprisingly few problems, such as everyone wanting Friday afternoon off. They seem to get together to decide who'll do what, making sure the place will still function. By helping shape something that has always been a management decision, they accept part of management's responsibility.'

At The Bay, flexibility extends even to the thousands of part-time workers who staff the retail stores during peak hours.

'We used to hire and train a part-time saleswoman, then call and tell her when to come to work,' says John English. 'Now we *ask* if she'd like to come in on a certain day. If she doesn't, we try to arrange it for another day. It's tougher for us to organize, but we're getting used to it.'

Revolutionary as this new working day is, it's no panacea. So, companies are matching their explorations in time-bending with efforts to improve internal communications, in an attempt to make the individual feel less of a cipher.

At North American Life, some 700

employees were divided into 70 groups, and each individual was interviewed personally by a member of management (but never that individual's superior). Some of the talks ran four days. Out of this came the new work week options, an improved grievance procedure, and a number of employee committees devoted to making other specific recommendations for change.

'The committee members took their responsibilities seriously and didn't ask for impossible things,' says Gary Webb. 'They behaved like management, looking at the needs of the company as well as the desires of the employees.'

In 1972, Imperial likewise paid new heed to the employer/employee dialogue, setting up a revised procedure for employee appraisal. It includes a discussion that gets right to actual job performance, enabling an employee to know exactly how and why he is being evaluated. Each appraisal is reviewed, in most cases, by a formal committee, to make sure that fair, uniform standards are being applied. If a problem shows up, management is expected to find a remedy. Unless each appraisal includes a firm plan to help each employee better his performance, the company considers the procedure incomplete.

The most significant point emerging from these changes is that companies are *willing* to change, and to discuss openly with employees subjects that were once regarded either as sacrosanct, or as flouting traditional union policies.

'A better educated and more affluent work force is chafing under the unresponsive nature of the institutions they are part of: employer and union,' says Imperial President Armstrong. 'That means the time has come for those institutions to change. Let's concentrate not only on the merits or disadvantages of a three-day or four-day week or of flexible time. Let's concentrate on becoming more flexible to the trends in society that affect how people want to work.' □

Reg Boate's '54 Packard convertible has never seen snow. It's worth $ 10,000

Dan Yake's '49 Chrysler Town and Country is one of three venerable Chryslers he owns, and he drives it only on Sunday

1953 Corvette owned by the late Dr. Don Wallace is a maverick with an 8-cylinder engine bigger than any other that year

The Cars of the 50s

They're not old enough to be antiques, but they're too classy for the used-car lot

by Robert Collins/photos by Barry Dursley

It was a good year for being in and out of love. It was 1953, and on the new gadget called television, Doris Day was crooning the Academy-Award-winning song, 'Secret Love', while Hank Williams was grievin' about 'Your Cheatin' Heart'. The handsome Senator John F. Kennedy was marrying the gorgeous Jacqueline Bouvier. The Liberals were wooing and winning the Canadian electorate for the fifth consecutive general election. Brunettes everywhere were hating Marilyn Monroe for making a movie called 'Gentlemen Prefer Blondes'.

Out on the curbs of our nation, flocks of young guys, perched in rows like sparrows, were fondly caressing their ducktail haircuts and watching the girls and the cars go by, with equal affection. The dowdy wartime years were long past; automobiles were stylish again. And this was the year a

Lila and Anne Bartoletti polish up their 1953 Buick

To maintain a car like the Bartolettis' Buick, you must wash it once a week, polish it with loving care, and never allow the salt of win

ving to attack its perishable steel

Toronto teenager named Mario Bartoletti fell in love with the Buick Skylark convertible.

Such a car! It was Buick's custom-built golden anniversary special, equipped like no previous Buick in history. Its body flowed in an elegant sinuous line from chrome-encrusted grill to double-bubble tailights. Its standard equipment included automatic transmission, power brakes, power steering, power windows, power seat, power aerial and a foot-controlled signal-seeking radio. You could have your name engraved on a golden emblem plate on the hub of the steering wheel.

Ogling the magazine advertisements, Mario could almost see 'Bartoletti' on one of those name plates. But, although his father was a Buick fancier, this one at $7,000 was a bit much for most wallets. Mario never really expected to own one, or that the '53 Skylark would become a bona fide antique.

A 1953 *antique?* But surely antique cars are *ancient* with spindly fenders rising above the wheels like arched eyebrows, and great brass-trimmed goggle-eyed head lamps, and horns that croak AHROOGAH. That's how it used to be.

Trouble is, the country is running out of little old widows with mint-condition McLaughlin's or 1912 Model Ts locked away in their garages. Where such cars exist, their prices run into tens of thousands. So, 10 years ago, the Antique and Classic Car Club of Canada invented a new category: the Postwar Thoroughbred. It was instant nostalgia for all the middle-aged men of today. Suddenly their boyhood cars, or some of them, were collectors' items.

Other clubs around the world eagerly embraced the idea. Not *any* old Ford or Chev will qualify, but special cars of the period as designated by the clubs are now coming out of junkyards and dusty garages, to be pampered, polished and treated as *objects d'art.* Such a car is Mario Bartoletti's Skylark convertible.

In 1959 after a stint in the Navy, Bartoletti was married, father of a baby girl, studying psychology at the University of Connecticut and driving an undistinguished '52 Buick coupe. One day, passing a used-car lot, he saw it, bedraggled but unmistakeable: a Skylark convertible! Six hundred dollars, the dealer said. They settled for $300 and the trade-in.

'I don't think he knew what he had,' Bartoletti says now, speaking in capital letters as though referring to the Holy Grail. 'He didn't realize he had a Golden Anniversary Skylark.

The used-car dealer was not alone in his ignorance. Many worthwhile cars were ending up as scrap metal.

'I've never forgotten a picture I saw of a beautiful old DuPont phaeton, sitting in a wrecking yard,' says Peter Weatherhead, a dapper young lawyer, editor of the ACCC's magazine, *The Reflector,* and a moving spirit behind the new classification. 'Truly beautiful cars are fine art, regardless of year. They don't have a cut-off point.'

Nevertheless, most of today's antique car clubs, founded in the 1950s, set 1942 as the cut-off year for an 'antique', and were reluctant to change. Yet newer members were more interested in cars they'd coveted as teenagers, rather than vintage specimens they couldn't find or afford.

So in 1964, after much soul-searching, the ACCC established the thoroughbred class for cars 12 years old or older (but nothing prior to 1942), of 'exceptional merit' and restored to near-mint condition.

'High price, quality of construction, custom body, rarity of

body style, and a low production run are some of the features we look for,' says Weatherhead. 'But we also consider function, meaning that even if the car was not particularly high priced, but was perfectly suited for the job it had to do, it would have a chance of joining this group.'

The 1953 $7,000 custom-built Skylark, with a production run of only 1,690, certainly qualified on all counts. But Mario Bartoletti regarded it as a friend more than a collector's item.

'After a couple of years my wife and I knew we were nuts about it and would never sell it. So we never allowed it to become run down. It was our only car for several years, and was like a member of the family. The kids even gave it a knickname: 'Little Peep'. Because it's a Skylark, you see.'

Other clubs quickly adopted the new classification. Lord Montagu of Beaulieu picked it up for England, where he is proprietor of a national auto museum and a guiding force behind the country's old-car movement. In the United States, the Milestone Car Society is a nationwide club entirely devoted to postwar thoroughbreds, thanks to Canada's lead. But in the founding ACCC, older members greeted the postwar class with a sneer. Some were 'afraid of turning the club into a used-car lot'. Others complained that the postwar models didn't *look* old enough.

'Certainly many of them are so well styled they don't look very different from today's car,' admits Weatherhead. 'They're not as blatantly different as the styles of the 1920s or '30s. But they can't be faulted for that. If anything, it's a tribute to their designers.'

Gingerly, the ACCC singled out a few special models from the membership: a 1954 Corvette roadster, for instance; a 1948 Chrysler Town and Country convertible; a 1950 Jaguar XK120; a 1953 Kaiser Dragon. In all cases the owner must persuade the selection committee that his car is worthy of the official nod. Even today only about 16 postwar models have qualified.

'But I hope more owners will come forward, now that the idea is catching on,' says Weatherhead, who has a custom built 1964 Riviera in his garage, waiting to be refurbished. 'This category is something like early Christianity: when it's accepted, more of us will come out of hiding!'

But Little Peep never had to worry about being thrown to the lions. It was always the Bartolettis' family pet. Newer cars came and went but Little Peep stayed on, going out every summer for maybe 600-700 miles of family driving. As its odometer went to 100,000 miles the three Bartoletti daughters merely loved it all the more. One night they sat down around the piano and wrote a song:

One time back in '59
While in a used-car lot
Daddy stopped and looked at her
And bought her on the spot.
He took her home and shined her up
As pretty as can be,
And even though she was so old
Little Peep looked quite loverly.
(Chorus)
Beep beep goes Little Peep
As merrily we drive along.
Beep beep goes Little Peep
Singing a happy Skylark song.

Sentiment is one thing but Mario Bartoletti is also a practical man. For years he prudently gathered spare parts from junkyards and flea markets. Keeping a postwar thoroughbred isn't easy. Whereas some firms now specialize in complete replacement parts for, say, 1920s Fords, there is no such service for postwar models. And while you could simply bolt a new fender on to an early car, it's not that simple with the moulded auto bodies of the 1950s.

'I respect immensely anyone who gets into this category,' says Weatherhead. 'It's difficult and expensive. It takes real dedication.'

Club member Peter Simms, a Jaguar addict who works for

From the top: 1954 Packard convertible, 1953 Corvette, 1949 Chrysler Town and Country convertible

Procter & Gamble in Alberta, is the classic example of dedication. In December 1964, while living in Toronto, he got a hot tip: a beat-up 1950 Jaguar XK120 roadster was for sale. Simms found it in a crumbling garage, 'the bare bones of what had once been a magnificent car, perched drunkenly on four oil drums. I had already been told the car was 'stripped', but 'gutted' would have been a truer description.'

The windscreen, bumpers and upholstery were gone. The engine was dismantled and the car had been ravaged by fire. Simms bought it, and a bonanza of spare parts, for $75. He hauled the wreck home and went to work.

By the spring of 1967 the Jaguar was reassembled, sanded, partially painted and re-wired. Simms was determined to show his prize in the ACCC's autumn 'Concours d'Elegance'– *the* antique car show of the year. He worked all summer at the lacquering.

With the Concours a week away, every remaining job was allotted to a specific number of evening hours. Simms worked until four a.m. the first night, three a.m. the second night, then decided to take the rest of the week out of his annual vacation. He worked right through the last night, re-upholstering.

Red-eyed and weary on Concours morning, he discovered one mistake: the door on the driver's side wouldn't close. Simms refused to give up. Holding the door shut with one hand, he drove to Toronto's Inn on the Park and rode in the Concours – a postwar thoroughbred owner, fulfilled.

It is a sunny autumn day in 1973, again at the Inn on the Park and another ACCC Concours d'Elegance. Among vintage cars dating back to the reign of Queen Victoria stands a little island of vehicles belonging to the reign of Chubby Checker and The Four Lads. A Chrysler Town and Country wagon. A flaming red 1950 Allard. A rare 1947 HRG Roadster, English-made. A splendid pearl-grey 1954 Packard convertible.

'Got it in Ohio,' says owner Al Webster of Gormley, Ont., talking in bursts from the corner of his mouth, while he keeps on polishing. 'Only 13,000 miles on it. Had one just like this in '59 when I was 25. So when I saw this I just bought it!' He has since sold it to Reg Boate, of Toronto.

And, naturally, Little Peep is there. Mario Bartoletti, tall and affable with thinning hair, is Executive Director of the Markham Family Life Centre and Co-ordinator of York University's Family Life Program. But there he is with his head under the Skylark's hood, manicuring the engine. His 13-year-old daughter, Anne, is helping. Little Peep's flanks are pure white; the red upholstery is perfection; the chromium trim blinds the eye.

'The children are so fond of this car that my wife and I have made special provision for it in our wills,' says Bartoletti. 'If anything happens to us the Skylark is willed to them, along with certain family heirlooms.'

And Little Peep sits there twinkling in the sun, beloved and loverly, a long long way from that 1959 junkyard. □

Pure bliss! A sparkling fall day, the family with him, and Mario Bartoletti at the wheel of his 1953 Buick Skylark

Imperial's artificial island in the Beaufort Sea permits year-round drilling operations in this promising but hazardous region

ENERGY from the frontiers

The Canadian oil industry has been exploring off the coasts and in the Arctic since 1947. What have they found? What are the prospects? What risks do they still face?

The most unusual oil drilling site in Canada today is Immerk B-48 in the northwestern Arctic. It's a little man-made island, a $5 million blip of frozen gravel in shallow Mackenzie Bay, 12 miles offshore from the delta of the Mackenzie River.

Why build an island? Because the prospects for gas or oil appear good just offshore from the Mackenzie Delta but shallow water and the unpredictable movement of pack ice rule out an offshore rig of the type used, say, off the Atlantic coast. So Immerk is really a permanent drilling platform. Imperial dredged it out of the sea-bed in 1972. It came through the 1972-73 winter intact and its construction was completed by mid-1973. A rig began drilling from the island last September in the windswept vastness on the brink of the Beaufort Sea: testimony to the particular ingenuity and expense that must go into Arctic exploration.

Companies have been exploring for oil and gas in the Canadian Arctic since the winter of 1947-48 when Imperial carried out a geological reconnaissance by dog sled. Industry began exploration off the Atlantic coast in 1960. At one time or another, more than a hundred companies have taken part in the search, either directly with their own equipment and staffs, or indirectly through participation with operating companies. So far, they have spent more than $800 million in the Arctic and another $300 million off the east coast.

The reason for it all is energy.

Despite the accelerated research into the development of nuclear power, into economical and environmentally acceptable ways to use coal, into ways to harness the power of the sun – conventional oil and natural gas are the world's major sources of energy, and likely will remain so for the predictable future. But oil and gas consumption is increasing rapidly, and concern over future shortages of these essential fuels has caused a worldwide acceleration of the search for new reserves.

Do undiscovered reserves of oil exist in the frontiers? All the evidence indicates they do. The amount of undiscovered oil in Canada has been estimated by the Geological Survey of Canada to be about 84 billion barrels – more than five times as much as has already been discovered in all Canada. About four billion barrels of this lies in the western provinces, in small pools widely scattered throughout the area and consequently difficult and expensive to find.

By far the largest potential – some 80 billion barrels – lies in the frontier areas, primarily the Arctic and Atlantic basins. And of this potential, about 80 per cent – 63 billion barrels – lies offshore, much of it in areas where the technology to drill for and develop the resources does not yet exist. Yet the need for energy is so pressing that the search for these potential reserves has been carried forward intensively for more than a decade, at costs

The most intense exploration for new sources of oil and gas in Canada today is taking place in areas far from markets in the harsh climate of the Arctic or beneath the stormy waters off the Atlantic coast

that have already surpassed a billion dollars. Canada's production of oil and gas will begin to decline within 10 years, and new supplies must be available if shortages are to be avoided. It is this urgency that infuses the frontier search.

The risks the oil and gas industry face are in keeping with the size of the reserves and the costs of finding and producing them. One of the risks is inherent in all oil exploration; oil in the earth occurs in pools, widely scattered and of various sizes. Despite all the expertise of geological science, you don't know if there's any oil in any particular place until you drill. Each hole adds to your knowledge of the region, but luck and perseverance still play large parts in oil exploration. The conditions of the hunt are such that a few companies can expect to be successful, and a few more will break even. Most will be unsuccessful. In the western Canada basin, for example, there are about 800 oil pools, but more than half of the basin's reserves lie in just 15 pools. It is the expectation of finding the big pools that attracts investors and pays the costs of the search.

Explorers face other risks that have nothing to do with the distance or the geology of the frontier basins, but are just as real – prices, markets and government share of the resource.

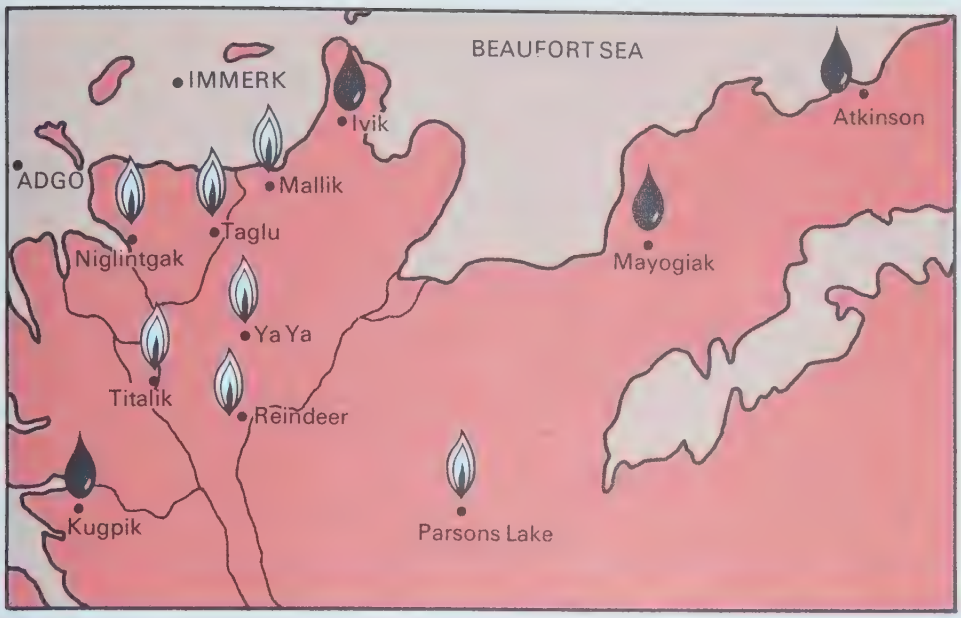
The price of oil and gas is a risk for frontier explorers in the sense that it places a lower limit on the size of the pool they must find to be successful. If the price rises, smaller, less prolific pools become profitable. But if it falls, the explorer must consider the venture a failure, for it would cost him more to produce and deliver the oil than he could sell it for, and he would go bankrupt.

Another risk is marketability. It does an explorer no good to discover a large, prolific pool if he cannot sell the oil or gas. Transportation costs and the economies of scale require large markets if the costs per barrel are to be economic, and this means that export markets for oil and gas that is surplus to Canadian needs must be available. The natural export market for Canadian oil and gas is the United States; if this market can be relied upon, development in the frontiers can go ahead; if not, the frontier search will be delayed, for the revenue from Canadian sales alone would not cover the costs of frontier oil and gas.

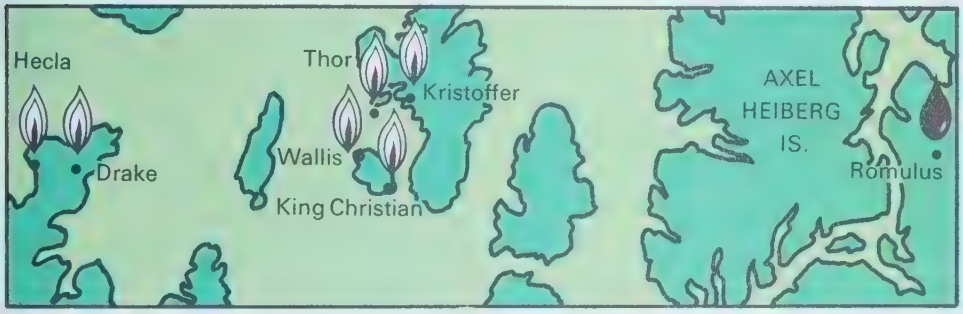
The third uncertainty facing explorers is government share in discoveries. The oil industry contributes to the federal government mainly through income taxes and royalties on production. When a discovery is made the government also benefits from the portions of the lease that revert to public ownership for subsequent development or sale. The size of the total government share has a bearing on the size of a pool that can be developed economically, just as price and market do. If the share is too large, or if government intentions about its share are uncertain, explorers are inhibited and development of the necessary reserves becomes unsure.

Price, market availability, and government share are matters that can be determined by public policy. The risks from these sources can be increased or diminished by government decisions. Ironically, such actions cannot do much to hasten a discovery in the frontiers, but by creating uncertainty about prices, markets and government share, they can slow the pace of exploration.

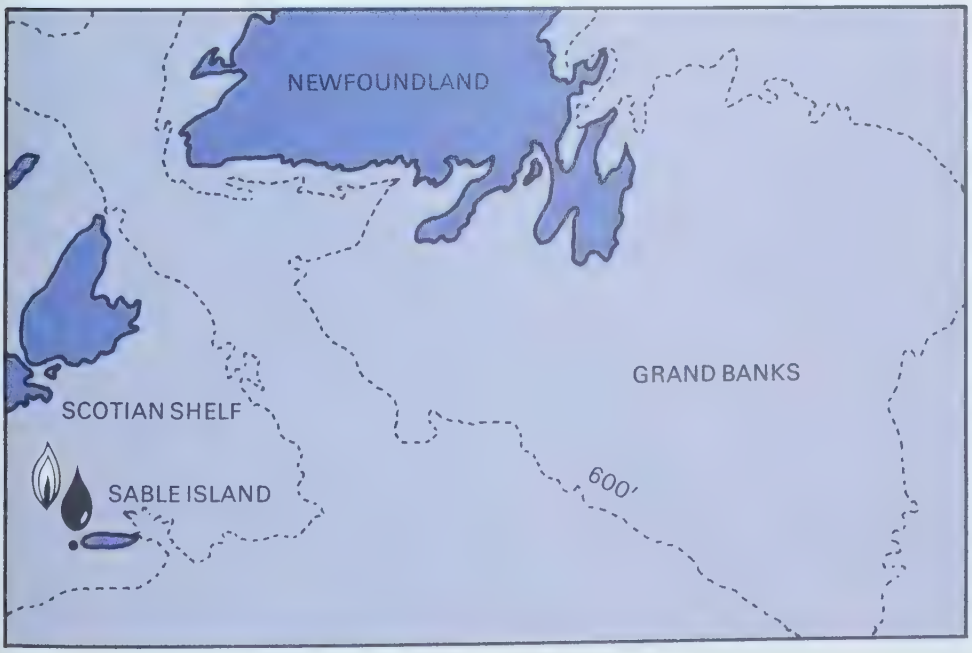
Despite these risks, the oil industry is



Significant quantities of gas have been discovered in the Mackenzie Delta, as well as some oil. Offshore wells are being drilled at Immerk and Adgo



In the islands of the high Arctic, six significant gas pools have been found, as well as two oil discoveries, neither of which is commercial



Atlantic discoveries include six gas and oil wells on and near Sable Island. With partners, Imperial is exploring under the waters of the Grand Banks

OIL DISCOVERIES GAS DISCOVERIES

deeply involved in the search for oil and gas in Canada's frontier areas. It can take 10 years or more to transform a discovery there into production, and since you can't predict when a discovery will be made, you have to start searching long before the need for raw reserves is upon you.

What has the industry found ? The Canadian Arctic provides two prospective producing areas: the Beaufort area (the mainland around the Mackenzie River Delta and the adjacent shallow waters of the Beaufort Sea) and the Arctic Islands (the islands of the high Arctic and the waters between them).

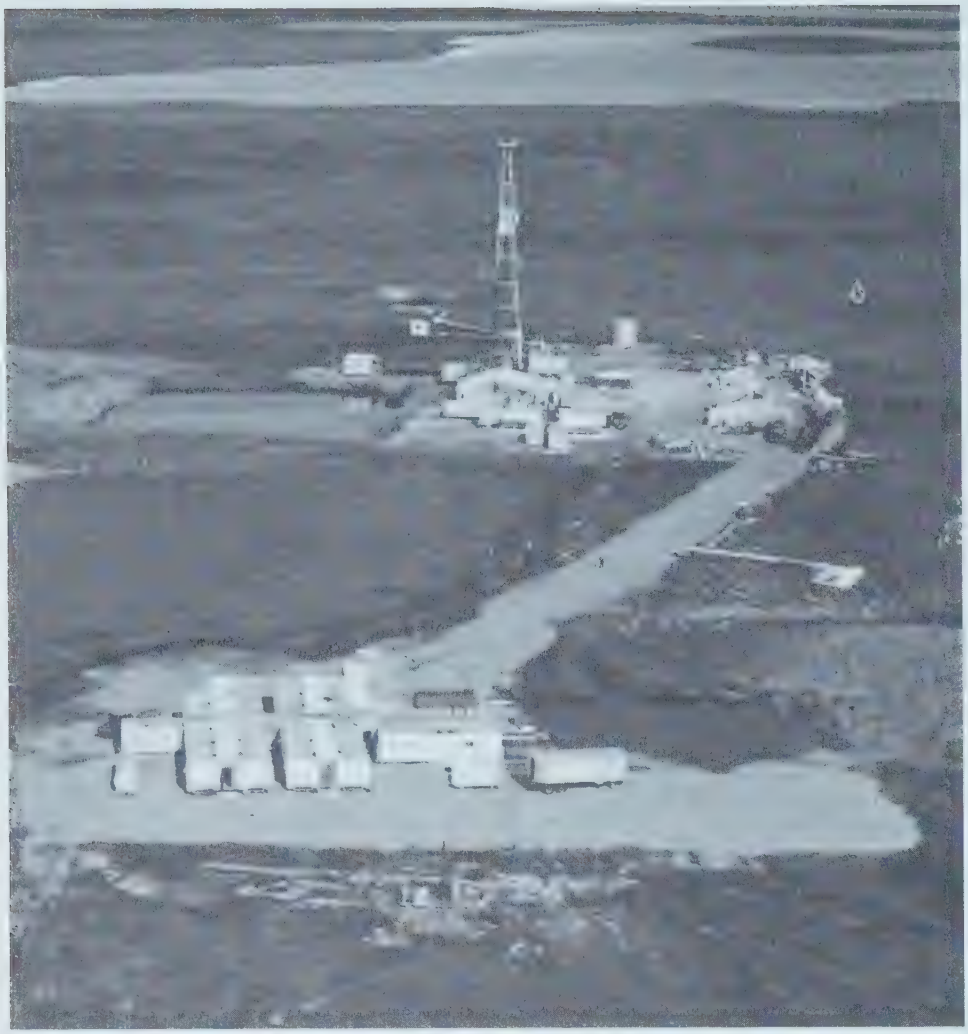
In the Beaufort area, the industry has drilled a total of 66 wells, of which four found oil and 11 found gas; 51 were dry. During the first round of the 1973-74 season, more wells will be drilled, including Imperial's on Immerk Island.

The success rate of Imperial and associates in this area has been relatively good. Besides the initial oil discovery at Atkinson Point in 1970, Imperial found oil at Mayogiak, six miles east of Tuktoyaktuk, in 1971, and at Ivik, also in the Mackenzie Delta, in 1972. At Atkinson Point a medium-gravity, low-sulfur crude flowed to the surface from a depth of 5,700 feet. Mayogiak produced a light-gravity crude from 9,400 feet, while medium-gravity crude and natural gas flowed from 8,100 feet at Ivik.

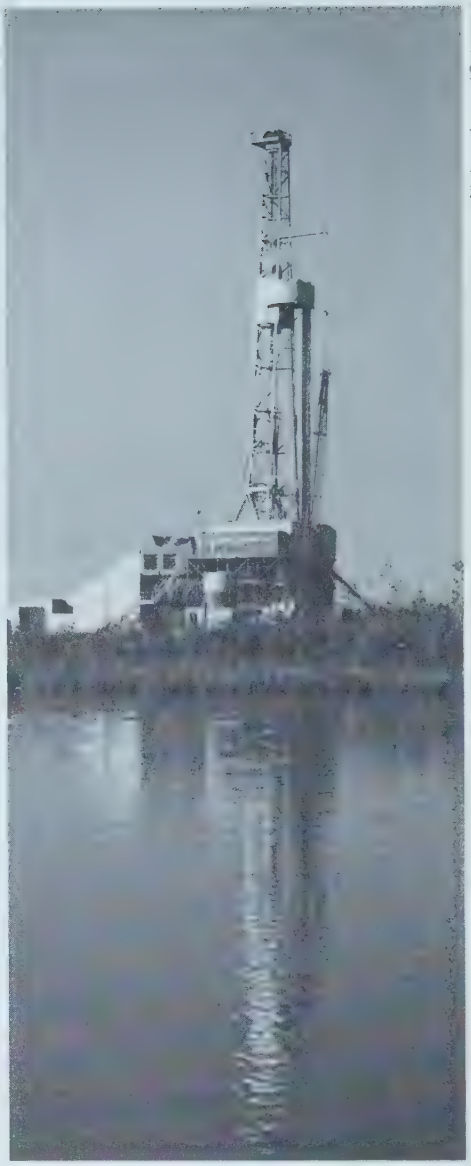
Imperial has drilled four gas wells at Taglu and one at Mallik, and, with partners, gas wells at Titalik and at Reindeer. Other companies have also drilled gas wells in the Beaufort area: two at Parson's Lake and one each at Ya Ya and Niglintgak.

The oil found so far is insufficient to warrant commercial development, but the gas finds are described as 'significant' by Imperial President J. A. Armstrong. At the end of September a team of geological consultants – J. C. Sproule and Associates of Calgary, and DeGolyer and McNaughton of Dallas, Texas – reported that the reserves of recoverable natural gas discovered in the Mackenzie River Delta then amounted to seven trillion cubic feet, and that the potential reserves were about 55 trillion cubic feet.

In the high Arctic, all the discoveries so far have been in the Sverdrup Basin, which underlies the northern half of the Arctic Islands, north of Viscount Melville and Lancaster Sounds. Sixty-seven wells have been drilled. Two, drilled by



Imperial's second oil discovery in the Arctic was at Mayogiak in 1971



On Richards Island in the Mackenzie Delta Imperial found gas at Taglu C-42 in 1972

All photos Imperial Oil Limited

Trailing a seismic cable, an Imperial crew explores undersea sediments off the east coast. A pair of these ships cost $20,000 per day to operate

Helicopter-borne surveyors measure water depth for a possible harbor at Axel Heiberg Island

Experiments in iceberg-towing seek to eliminate this hazard to Atlantic drilling operations

Panarctic (which is 45 per cent owned by the Canadian government) on Ellesmere Island and Thor Island, showed oil but were suspended. Neither is rated significant. However, 12 gas wells have been drilled and have indicated six significant gas pools.

Imperial's activities in this area are on farmed-in acreage from Panarctic in the eastern islands. The company has drilled and abandoned four wells at Devon, Hoodoo, Mokka and East Amund and participated in the drilling of a fifth unsuccessful well at Depot Point. A sixth is being drilled near Sherwood at the southern tip of Axel Heiberg Island.

Panarctic is currently drilling the deepest and one of the most expensive exploratory wells in the North: to 18,000 feet in the Drake Point gas field on northeastern Melville Island, at an estimated cost of $5 million. Meanwhile, in the Sverdrup basin, geologists believe that much of the potential lies offshore, which poses a tremendous challenge. A means must be found to drill in water deeper than 600 feet and covered by ice most of the year.

The discovery rate off the Atlantic coast has been lower. Of 69 wells drilled, 63 were dry. Six gas and oil wells have been drilled on and near Sable Island. Imperial is participating in a drilling program in the Grand Banks region. Other areas being explored include the Labrador-Baffin Shelf (where icebergs interfered with the first attempt to drill), the Gulf of St. Lawrence, the Scotia Shelf off Nova Scotia, which includes Sable Island, and the continental slope where water depths are as great as 12,000 feet.

The technology for drilling in water of this depth is still evolving. Nowhere in the world to date has exploration drilling been carried out in water depths exceeding 1,500 feet, and off the eastern Canadian coast, no deeper than 450 feet.

Meanwhile, back in the Arctic, Imperial continues its island-building ways. It has built another island, about 19 miles southwest from Immerk. It was built with a clamshell dredge, with a gravel outer dyke enclosing an area 150 feet by 600 feet, which was then filled with plentiful silt. Immerk Island was built with a suction dredge, and almost exclusively from gravel dredged from an underwater deposit nearby. A well, Adgo G-28, will be drilled this winter from the new artificial island. □

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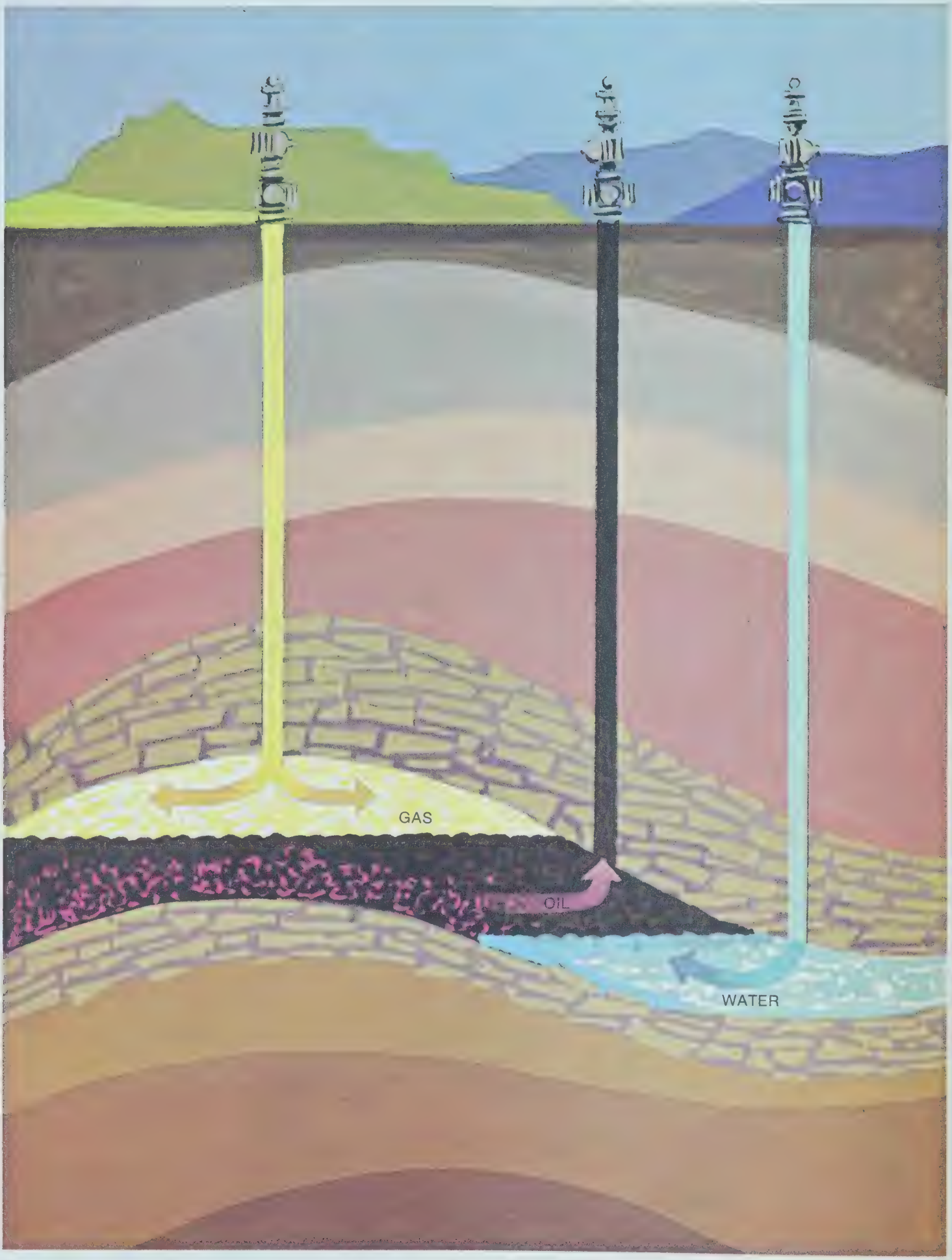


To recover more oil from a producing well, gas can be injected above the oil and water pumped in below it

The Last Drop

When it comes to oil, you can't get it all out of the ground. But you can recover a lot more than Nature alone gives up

by Jean Martin/drawings by Eric Aldwinkle

If oilfields were people, Golden Spike would be a medical marvel – one of those multiple-transplant patients, doing very nicely thank you against all the odds. For example:

In 1949 when an Imperial Oil wildcat well brought the field in, 25 miles southwest of Edmonton, everyone said it was a beautiful baby. Not a Leduc or a Redwater as oilfields go, but certainly a major find.

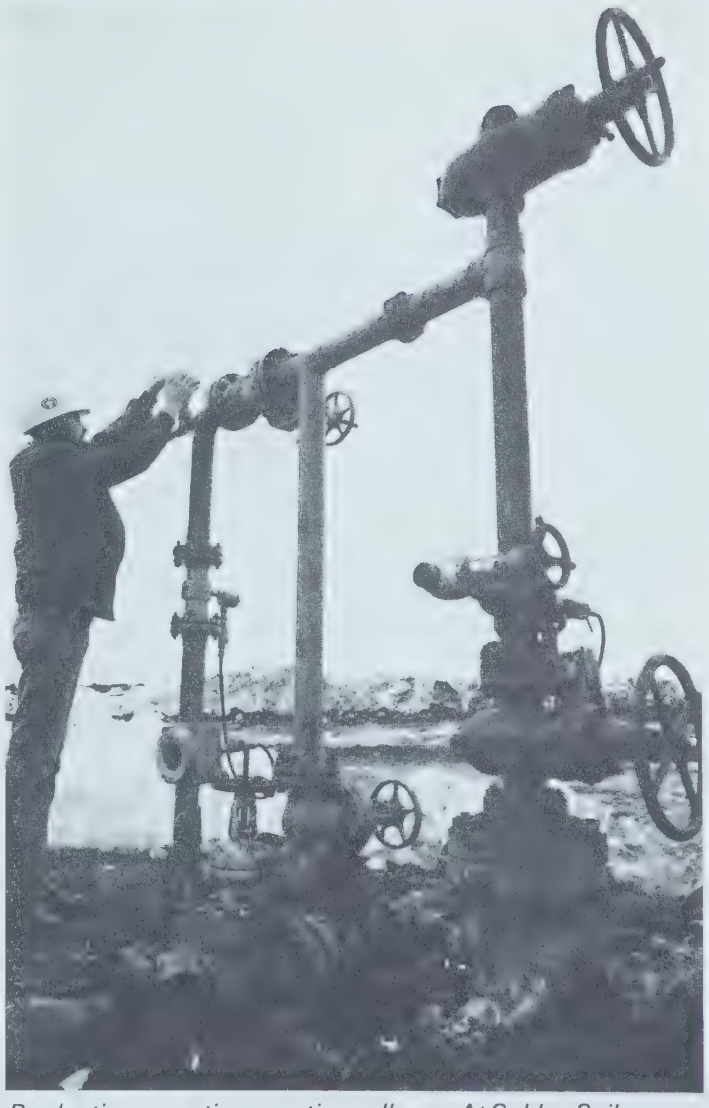
But within five years it looked as though Golden Spike would never reach maturity – an acute case of weakening of the pressure, the diagnosticians said. Now, thanks to a couple of 'operations' (secondary recovery, to be technical about it) in 1954 and 1963, the field is alive, well, and expected to produce a phenomenal 90 per cent of its original 310 million barrels of crude.

Secondary recovery means coaxing more crude oil out of the ground than the ground really intended to give up. By means of man-made water pressure, gas pressure and other more exotic methods, it has given hundreds of old fields a new lease on life, doubling or even tripling their output. That's a handsome bonus in these times of increasing energy demand. It's like finding new oil deposits without having to look for them.

To appreciate secondary recovery one must realize that recovery of *all* the oil or natural gas from any underground reservoir is never complete. Sometimes the natural or primary recovery is as low as four per cent; rarely is it higher than 50 per cent. Throughout Alberta, for example, only about one of every three barrels of the conventional oil in place is likely to reach the surface. Alberta's discovered oil in place has been estimated at 33 billion barrels. Of that, 11 billion barrels (including the oil produced so far) is presently deemed recoverable. But if it were not for secondary recovery, only about 7.3 billion barrels would ever be recovered.

All together, 350 projects – 2,600 injection wells shooting 1.6 million barrels of water, 136 million cubic feet of natural gas and 46,000 barrels of solvent into the oil and gas zones

Chris Bruun/Imperial Oil Limited



Production operations continue all year. At Golden Spike, Alta., solvents are injected to increase oil recovery.

Natural force of compressed gas dissolved in the oil seldom produces more than 50 percent of the oil in place.

every day – are adding to Alberta's recoverable reserves.

Why do we need secondary recovery? Because crude oil itself has no driving force. If left to its own devices it would just lie inert in the pores of sedimentary rock. It must be pushed to the surface by pressure. The pressure may come from water lying under the oil deposit, from compressed natural gas above it, or from gas in solution with the oil somewhat like the carbonation in a soft drink.

Some oil fields are blessed with strong natural pressure; some are not. The techniques of production can make the most of that pressure – or simply fritter it away. Turner Valley, the first significant strike in Alberta, early in this century, had an estimated one billion barrels of oil in place. But before the oil was found, much of the overlying natural gas was produced. Consequently, only about 12 per cent of the crude oil has been recovered. Secondary recovery, in effect since 1948, will contribute only about two per cent more.

Golden Spike, on the other hand, is living up to its potential, with a little help from its friends. It is an unusual field: small but thick. Its area is about 1,320 acres, while its 'pay' or oil-bearing section originally was 545 feet thick. The famous Leduc field nearby covers 14,500 acres, and its original pay zone averaged about 38 feet.

Golden Spike's main drive originally came from the oil in compression. But within five years the original pressure of 2,095 pounds per square inch had dwindled to an alarming 1,390, and was still going down. At that rate Golden Spike's production rate would soon have dropped.

Imperial scientists in the Calgary laboratory compiled a statistical history of the field, including estimated reserves and rate of declining pressure. The calculation predicted that, without man-made assistance, Golden Spike's pressure would die with about 45 per cent of the oil still in place.

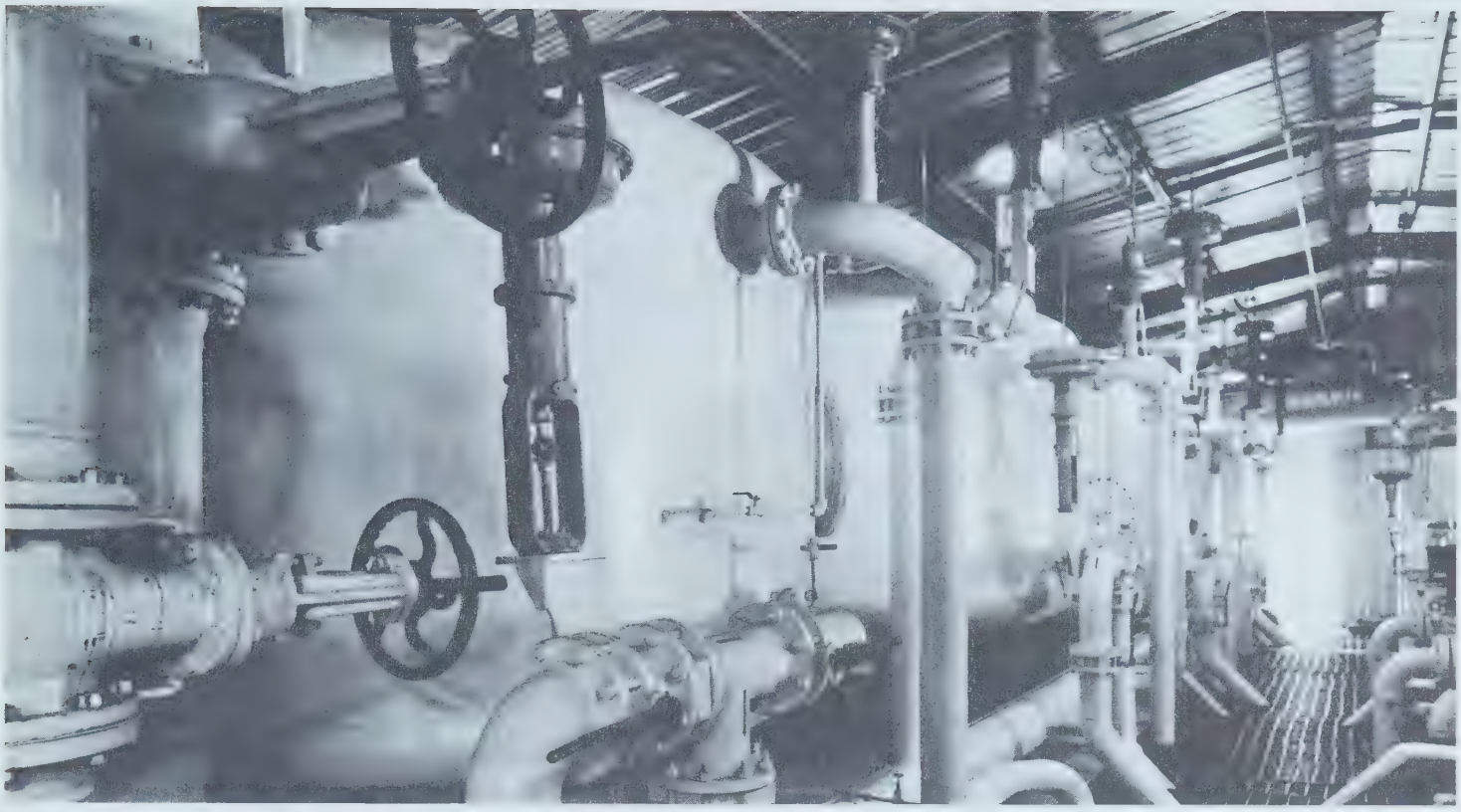
Imperial built a $2.5 million gas injection plant, began forcing 20 million cubic feet of gas from other fields into the top of the field each day and held the pressure at 1,800 pounds per square inch. This was expected to retrieve 70 per cent of the field's crude oil.

Pressure maintenance was not new, even then. It had begun before in the 1940s, but it grew in sophistication with the bonanza of oil and gas discovery in Alberta during the 1950s and 1960s. Through research, the oil producers realized there is an optimum point for the beginning of any such program. Secondary recovery usually begins before natural pressure is seriously depleted, but the field must usually also have a few years' history of production before a workable program can be devised. Given these ingredients, modern computer technology can build an accurate profile of an oil field's future.

At that point, the exact recovery technique employed depends upon the nature of the individual field. Most Alberta oil fields are underlaid by water, which contributes to the recovery in some degree. In these fields, water is injected into the underlying aquifer to supplement the water 'drive' and maintain resevoir pressure. In other pools without naturally-occurring water, waterflooding is the commonest technique. Together, these methods account for nearly 90 per cent of the oil recovered in the province. As the name implies, it forces large volumes of water into the field at carefully selected points which in turn provide pressure to force more crude oil from the producing wells. Ideally, the artificial pressure matches the original natural pressure of the field.

The water is no ordinary ditch-water either. It must be treated, and in some cases is more pure than water for human consumption. Sediments that might clog the tiny pores of oil-bearing rock must be filtered out. The water must also be chlorinated and de-aerated to discourage bacteria from growing in the reservoir and clogging the rock pores and to prevent corrosion of pipelines.

At Golden Spike, solvent driven by injected gas, 'scrubs' oil from the rock formation, producing 90 per cent of the oil in place



Water for injection into oil formations must be clean. At the Judy Creek field in Alberta, these vessels filter out impurities

There are two common waterflood procedures – 'peripheral' and 'pattern' – depending on the nature of the reservoir. In Alberta's Judy Creek field, for example, the oil-bearing rocks lie underground at an angle, or a 'dip' as the industry calls it, with water lying in the lowest part of the dip. Consequently, the producers have used a peripheral waterflood. The injection wells are selected at the edge of the field near the lowest incline of the producing formation. The water pressure floods in at the bottom, forcing the oil along the upward tilt of the formation, and out of producing wells. Without secondary recovery, Judy Creek would have slowed to a trickle after producing only 20 per cent of the oil in the field. It is now expected to yield about 50 per cent.

The Boundary Lake field, on the other hand, has less dip and lacks underlying water. Hence, each injection well is spaced among clusters of producing wells in a regular pattern all through the field. The waterflood forces oil to the producing wells surrounding each injection point.

But water alone can not push all the oil that clings stubbornly within the smaller pores of underground rock formations. Hence the turn in recent years to solvent or 'miscible' (meaning it mixes) flooding. In 1963, Golden Spike was the first oil field in Canada to get a gravity-controlled solvent flood. This technique is effective on a formation shaped like the Golden Spike field. The solvent, a petroleum product, is injected in a layer at the top of the oil zone, and is forced down through the formation by gas injection from above, pushing the oil before it. As with other methods, this one then forces oil to the existing producing wells in the field.

Fire is yet another way to bring up stubborn oil. It was first applied in Canada near Swift Current, Sask., in 1967, when air was pumped into an injection well and an electrical igniter

At Cold Lake, Alta., steam heats the heavy oil, reducing its viscosity enough to permit the oil to be pumped

In a waterflood project, water is injected into the formation through wells carefully spaced in relation to the producing wells. The water fills the spaces in the producing formation, forcing the oil to the producing wells for pumping to the surface

set fire to the oil formation. Combustion gases moved toward the producing wells, heating the oil (and making it flow better) and supplying additional pressure. The test produced twice as much oil, but the initial investment and operating expenses were high: about 20 times as expensive as conventional waterflooding.

Fire and water have been used in combination. In one experiment, water was flushed down injection wells after underground combustion, turning to steam when it touched the hot rock. The steam thinned heavy oil deposits. Steam is employed at Cold Lake, Alta., where Imperial's 23 pilot-project wells are producing as much as 1,000 barrels of crude per day. The Cold Lake crude is simply too thick to be recovered by conventional methods. In Imperial's project, steam at 600 degrees Fahrenheit is forced into the oil zone at a pressure of 1,600 pounds per square inch for about a month. Then, a mixture of water, gas and the hot, thinned oil is pumped out. Imperial is now building an enlarged pilot plant and drilling more wells.

Why not blast open those minute crannies of oil bearing rock? It has been tried, but so far with only limited success. The principle appears sound enough: a controlled explosion would create an underground chamber, perhaps releasing oil in the process and providing a place to pump in water, natural gas or solvents for further recovery. But conventional explosives have not been found powerful enough to do the job.

Explosions have been suggested to recover oil or gas by shattering formations to improve the flow

Chris Bruun/Imperial Oil Limited

Valves stand in the plant at Golden Spike where gas forces a solvent 'blanket' down through the producing formation

There have been controlled nuclear reactions, too, in United States experiments, and others are contemplated. This is one of the proposed methods of extracting petroleum from the vast shale deposits of the western states. (Oil shale is rock laced with a spongy paraffin called kerogen.) But even if the technique works, and leaves no radioactive materials in the oil or natural gas, U.S. officials fear that the public will be slow to accept nuclear 'explosions' in the nation's backyard, even for peaceful purposes.

Canada isn't contemplating any nuclear experiments. There is enough challenge in improving on the more conventional secondary recovery processes. Right now the question is: how much more of that so-called unrecoverable oil might be eked out of the earth? Is it too much to hope that another four billion barrels of Alberta's supposedly unreachable 22 billion barrels may yet be extracted?

Some Alberta experts think it is a real possibility. To recover this oil, exotic methods of recovery will likely be needed, and they will be expensive. High oil prices are necessary to make them economic. Yet four billion barrels represents about seven years' supply at Canada's current rate of consumption. It's equivalent to 13 Golden Spike fields – a target well worth aiming for. □

The Charles S. Curtis Memorial Hospital – still known as the Grenfell Mission – at St. Anthony, Nfld., near the tip of the island's northern peninsula

Newfoundland's Miracle Medical Mission

The 82-year-old Grenfell Mission brings sophisticated health care to Canada's stony, stormy Labrador coast

by Steve Lynett/photos by Barry Dursley

Tom Green leaned awkwardly against the radio transmitter at Charles S. Curtis Memorial Hospital and stared intently at the icy veneer that encased St. Anthony. A light rain had fallen steadily for 18 hours and showed little sign of stopping. For an hour, visibility had been decreasing sharply as fog drifted into the cradle of rock that protected the northern Newfoundland fishing village.

The mixture of freezing temperatures, rain and fog made travel by boat or car difficult. But for Tom Green, pilot, the combination put flying out of the question.

'You'd be a chunk of ice on top of the water,' he said, turning away from the window. 'No one flies today.'

It was a common enough pronouncement but its frequency offered little comfort. Green and the half dozen men gathered in the hospital's radio room knew all too well that bad weather was one of the major obstacles facing the Grenfell mission – the world's most advanced frontier medical network.

The Grenfell mission no longer has any religious affiliation. It is a hospital organization, paid for largely by the government with some support from private endowment funds, and its main responsibility is the medical care of most of the people of northern Newfoundland and Labrador. But it is more than that: in addition it operates school dormitories, and aids the local economy with a handicrafts enterprise and a facility for building and repairing fishing boats. Throughout its history, geography and climate have been its most formidable adversaries.

In the 82 years since it was started by a young English doctor who sailed a tiny hospital ship along the Labrador coast, the mission has evolved into a complex medical organization. Today, snowmobiles and aircraft have replaced the yelping dog teams that carried doctors and

nurses along the rock-strewn shorelines; faster transportation and advanced medical technology have made professional help more widely and quickly available.

Yet despite the technological advances, the mission's operation is not without snags. Take the weather for instance. Like rugged Labrador itself, the wind and rain pose special problems. Significantly, it is the obstacles that have preserved the spirit of the mission, a force that has lured an army of men and women from gentler climates and more comfortable cities to a life of frequent hardship and often intangible rewards.

It all started in 1892 when Wilfred Grenfell, a 27-year-old doctor with unruly hair and a scraggly mustache, left England to further his career as a medical missionary. As a representative of the Royal National Mission to Deep-Sea Fishermen, he sailed to Labrador to help the families of the thousands of cod fishermen who went there each summer. When he arrived, he found conditions far worse than he expected. Among the natives of Labrador – the Eskimos and Indians, its historical inhabitants, and the white families who had lived on the barren coast for a century – Grenfell found rampant poverty, ignorance and illness. In this demanding region there were few priests, no hospitals and rarely a doctor.

Immediately Grenfell started a move to alleviate poverty and disease. He built hospitals and set up nursing stations with money raised from donations. A master of many talents, he showed special prow-

The mission's hospital ship, the 98-foot-long Strathcona III, steams past the tanker Imperial Quebec, making a delivery of petroleum products to the mission. T

ess as a money-raiser. Newspapers found him colorful copy and, as his reputation spread, thousands donated to his cause. In 1912 the International Grenfell Association was formed in New York when the modest resources of the Royal National Mission and his own efforts were no longer enough. St. Anthony became his headquarters.

Perhaps the greatest gift that Grenfell provided was the inspiration that brought hundreds of men and women to the wilds of Canada's eastern border. Doctors and nurses from Canada, the United States and Britain worked for almost no money and a great legion of 'wops' – workers without pay – put their own money down to take a ride on Grenfell's glory road.

Grenfell took chances and faced death a number of times in his life but in 1940 the Labrador Doctor died in his sleep. His passing did little to disturb the progress of the mission. Already, Charles Curtis, Grenfell's protegé, was continuing the battle for better health care.

Confederation in 1949 probably had the most significant effect on the mission. With it came increased government assistance and eventually, in 1967, prepaid medical care for the province. Historically, all financing had come from the various agencies of the International Grenfell Association but now, as an agent of the Government of Newfoundland, the mission had a new source of support. But although it came under the wing of the government, the mission retained the spirit that had kept it alive

rathcona III is equipped with a dispensary, an X-ray laboratory and a dental unit

Nurse Sharen Madden left Windsor, Ont., for St. Anthony

The mission's pilots – Tom Green (left) and Tom Vlaming

throughout its early days.

Today, St. Anthony remains the nucleus of medical operations. All major surgery and specialized treatment is performed at the modern, 150-bed Charles S. Curtis hospital. Three smaller hospitals operate in the interior of Labrador at Happy Valley, North West River and Churchill Falls, site of the mammoth, $946 million hydro-electric power project. For the rest of the scattered towns and villages along the 2,000-mile coastline of Labrador and northern Newfoundland, medical care is dispensed from 13 nursing stations and community health centres.

What turns this collection of hospitals, nursing stations and health centres into a workable operation is a technologically advanced network of communications and transportation. A radio-telephone system puts all 13 outport stations in contact with St. Anthony. And standing by on 24-hour call is a trio of ambulance aircraft, ready to respond to any emergency. A hospital ship – the 98-foot-long Strathcona III – makes regular visits to outport stations. She carries a complete dispensary, an X-ray unit and a full range of dental equipment.

Grenfell headquarters – the Charles S. Curtis hospital – dominates the St. Anthony landscape, a ring of dark hills that fall sharply to a small harbor. With 400 salaried staff, the hospital is the largest employer in the area. Among its professional staff are 14 specialists, a number that few other hospitals its size can boast. Its medical facilities, the doctors believe, make it one of the best-equipped hospitals in Canada. For instance, the hospital can perform any operation with the exception of open-heart surgery and kidney transplants.

There is a wide range of backgrounds among the professionals and volunteers that come to St. Anthony, but almost all of them are pursuing an ideal. Although

After an eye operation at the mission hospital, Sidney Pilgrim (right) has his eyes examined by ophthalmologist Dr. Gordon Johnson

the country is beautiful at any season, winter is temperamental and cold; and mosquitoes and black flies are summer's constant pests. Clothes and food are expensive and night life is something the individual creates himself. But still, people come.

'I like my job and I really feel needed here,' says Sargent Horwood, 'I feel that if I left the job they'd have a hard time finding someone else.'

Horwood is 43, the father of two children and the mission's only full-time pediatrician. In May, 1972, he and his family left the affluent community of Los Alamos in the foothills of New Mexico's Sangre de Cristo mountains. For Dr. Horwood, a poised and articulate man, it meant leaving a lucrative private practice to live in a region where personal wealth is rare.

'In Los Alamos I was one of five pediatricians looking after a population of 25,000,' said Dr. Horwood. 'Now I'm the only person responsible for 50,000. It's a tremendous responsibility but it's also very gratifying. And people really appreciate you when they see you.'

Like Dr. Horwood, 37-year-old Gordon Johnson is one of a kind. The mission's only ophthalmologist, he and his wife Ann rejected a comfortable life in Toronto to join the Grenfell Association.

'I wanted a change from the city and a chance to do something useful,' he said. 'Unfortunately, you give up contacts with university and colleagues in the same branch of medicine. You must do all the work yourself so that there is little room for specializing. From an academic standpoint it can be quite unrewarding. But there are other rewards – like going to work in a plane over magnificent landscape instead of riding a stuffy subway.'

At 21, Sharen Madden is one of the youngest professionals on the mission staff. She lived in Windsor, Ont., before she became a staff nurse in the intensive

Lights begin to wink off as dawn breaks over the protected harbor at St. Anthony, spread out below the mission hospital. The ship is the Imperial Quebec.

care ward at St. Anthony. After hours she leads a girl guide group and teaches figure skating.

'There isn't a lot of entertainment and the region is just so isolated,' she said, 'but the thing that saves it, is that it's so beautiful.'

Why did she choose the Grenfell Association? 'It was from a desire to know a different way of life,' she explained. 'I wanted to change what used to be a narrow outlook on life.'

In the Grenfell organization, it's the outpost nurses that hold the front line. Gordon Thomas, 54, the executive director of the International Grenfell Association and its chief surgeon, says: 'These women are highly qualified and extremely dedicated. Many of them are as good as a general practitioner – they have to be because they're on their own if a doctor can't get in to help them.

And the pressure is on the outpost nurses when weather locks them in. Especially in Labrador, where the road system is all but nonexistent, evacuation is highly dependent on aircraft.

Tom Green, 32, and his 27-year-old companion Tom Vlaming, are full-time mission pilots. Between them they have ferried patients suffering everything from heart attacks to broken legs and landed on an assortment of lakes, ponds,

paved runways and cleared fields. Their common bond is a love of flying and a dislike of St. Anthony airport.

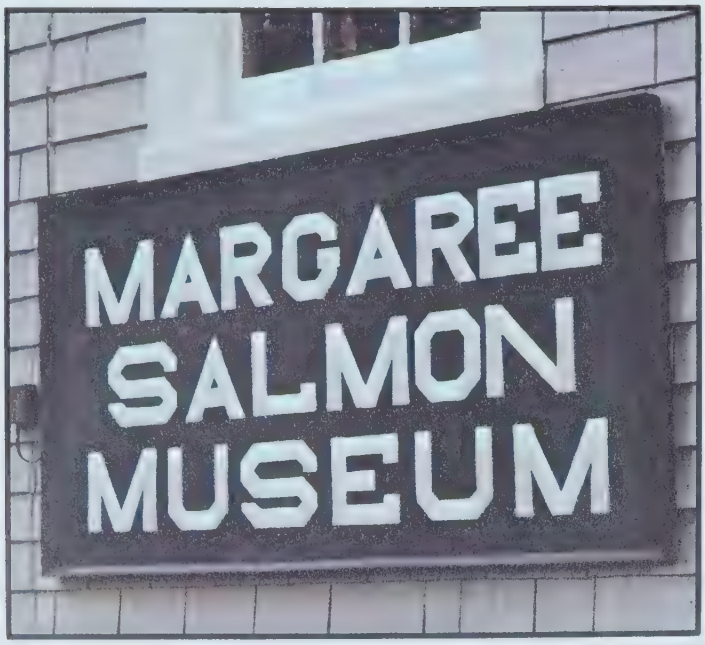
'The runway isn't in the direction of the prevailing winds,' says Vlaming. 'You're grounded by a strong crosswind.'

Vlaming's aircraft, the mission-owned, eight-seater, twin-engine Navajo, is restricted to smooth, solid runways, but Green's plane, an eight-passenger, single-engine Turbo Beaver is more versatile. The Beaver can get airborne even if it has to bump across an open field.

At the Harbour Deep nursing station, 80 miles south of St. Anthony, Green gets his toughest ride. Early in winter, when the aircraft has been converted from floats to skis but the harbor ice is not yet solid enough to support the plane, Green must land on a quarter-mile-long pond atop a 1,500-foot hill. Because the pond's surface is more slush than ice the plane must taxi gingerly to an island made of cut tree tops.

But the patient, too, must be brought to the top of the 1,500-foot hill – often aboard a dangling stretcher. A group of the town's men pull the stretcher with long ropes along a steep and narrow path to the crest of the hill.

How does Green get out? 'The same way I come in,' he says. 'You just have to be quick.' □



To learn about Salmon, go to Nova Scotia

Logging locomotive is part of British Columbia Forest Museum at

Kerosene lamp and spinning wheel recall pioneer days at Ontario's Sharon Temple, 21 miles north of Toronto

Denise Mooney

Ron Cole

Animated penny banks are in the Bank of Montreal's head office, in Montreal

Ron Cole

Canada's Roadside Museums

They provide informal glimpses into little-known aspects of our past

by Elizabeth Kimball

All across Canada, on pleasant side-roads and even, occasionally, hidden within great cities, small museums describe chapters of Canada's past that more famous museums often scarcely mention.

Alberta has a Ukrainian Village and Prince Edward Island a Car Life Museum and a French Acadian Museum. There is Nova Scotia's Barrington Woolen Mills; Vancouver's Hastings Mills; Ontario's Mining Museum at Porcupine; Joseph Brant Museum at Burlington and Hydro Museum at Toronto. Montreal has a Telephone Museum.

For instance, 21 miles north of Toronto, about one mile west of Don Mills Road near the Holland Landing cut-off, stands Sharon Temple. Unlike any other structure in the surrounding

Everything at Sharon is symbolic: 12 corner lanterns represent the 12 apostles

district, the three-tiered, white frame temple, sits back from the road in the centre of a finely trimmed lawn.

The temple commemorates the Children of Peace, a religious sect founded by David Willson, an Irish-American who settled a 200-acre Crown patent in what is now Sharon Village. A minister of the Society of Friends, he broke away and, with six followers, formed the Children of Peace in 1812. He designed the temple and was minister of the sect. He died in 1866, and is buried in Sharon Burying Ground.

The temple at Sharon was the sect's second building. Despite its splendor, Sharon Temple was normally used only once a month during ritual services at which church members contributed to a charity fund that provided money for the needy of the area. One of the first credit unions, the fund was also used by sect members if they were in need.

Regular services and meetings were first held in Willson's house; later in a one-storey structure that became the sect's music hall after they completed their second meeting house in 1842.

Construction began on the temple in 1825 and it was used by the sect until the late 1880s. David Willson was the architect, and Ebenezer Doan was the master builder. It took seven years to build, with the men of the congregation each contributing his own kind of work toward it. One cut lumber, another hauled stone; the windows are said to have been built at several homes; and Ebenezer's son, John Doan, spent a full year making the elaborate ark.

Every aspect of the structure is symbolic. The building's three tiers represent the Trinity. The columns surrounding the ark are inscribed Faith, Hope, Love, Charity. Twelve lanterns – one at each corner of each storey – represented the 12 apostles. At the time of the Illumination, the first Friday in September, the lanterns and one candle behind each of the temple's 80 windows were lit.

Many children visit the temple. And the question they ask most often upon entering through the temple's towering east doors is, 'What's upstairs?' Confronted with Jacob's Ladder, an extremely steep, 24-foot arching staircase, the young eyes slide along its polished surface to the second floor, a music gallery where, long ago, the band played.

The barrel organ, one of five organs in

the temple, was the first ever built in Upper Canada. It produced 20 different hymn tunes when operated by a big hand crank. And in the driving shed the children crave to climb aboard Ebenezer Doan's wooden buggy, driven from Pennsylvania in 1808. It is suspended on wooden springs.

Manitoba preserves its Mennonite heritage, and portrays pioneer life in the province and Western Canada, with a Mennonite Village Museum, 1½ miles north of Steinbach on Provincial Trunk Highway No. 12. Begun in 1964, its plans call for additions as each generation preserves the history of the preceding age.

The village contains a house-barn typical of early Mennonite villages in Europe about 200 years ago. Transplanted from Prussia to Russia around 1789, this unique plan came to Canada in 1874. The construction is distinctive: two-by-six scantlings laid flat, plastered inside, sided outside. Inside there is a huge brick oven in the main room, a compact little kitchen in the centre of the house, and a passage between the pantry and boys' bedroom leading to the barn, which is attached to the house.

This museum includes an original log house with a thatched roof, built in 1892, and a church, built in 1881. The church, formerly used by the Old Colony Mennonites of the district, was moved to its present site in 1968. An artifacts building, opened in 1967, houses early Mennonite heirlooms, including a wall map of the Mennonite migration, a collection of Mennonite clothing and another of old wall clocks. There is also a library of books and documents pertaining to Mennonite faith and history, the oldest dating back to 1588. Outside stands a monument to Johann Bartsch, an early Mennonite leader, that is chipped and pitted by shots fired during the Russian Revolution. The monument was shipped to Canada in 1968.

Also on the grounds is a replica of a windmill built in 1877 by Mennonite pioneer Abram Friesen. The replica was built from blueprints drafted in Holland by the Dutch Windmill Society. The basic framework, made up of eight Douglas fir poles, each 32 feet long, was assembled without nails. The mill tower stands 45 feet tall and each sail measures 32 feet. The two milling stones,

Ron Cole

Pillars surrounding a carved ark are labelled Love, Faith, Hope and Charity

Ron Cole

Part of the museum at Sharon, Ont., is this reconstructed log house

The home of the temple's master builder, Ebenezer Doan, was built in 1819

Ron Cole

each weighing 2,000 lbs., can produce as much as 800 lbs. of flour per hour.

The original mill cost $2,000; the replica cost $100,000.

The village has a large parking lot, and a place to picnic.

A former schoolhouse is now the Margaree Salmon Museum, 100 feet off the Cabot Trail at North East Margaree, N.S. The Margaree Anglers' Association, its sponsor, claims this is the only museum of its kind in North America. Its collection of old-time fishing tackle includes rods from seven to 18 feet, home-crafted and of just about every type, many sizes and types of reel, a horsehair fishline, old-time gut casts, trout and salmon flies, fly books, gaffs and fly-tying materials.

The museum has a display of poachers' paraphernalia, too; spears, jig hooks, nets and a flambeau for lighting the pirate fisherman's boat.

Stuffed specimens gape, glassy-eyed from their mounts, and very-much-alive young fish frisk in tanks.

British Columbia's Forest Museum is a mile north of Duncan (or 40 miles north of Victoria) on Trans Canada High-

Tiny, sunlit study, only 8 by 16 feet, was built for the sect's founder, David Willson, at the same time the temple was built

Willson's study is surrounded by a colonnade, reflecting the design of the temple itself, and painted the same colors

Ronald A Woodill

Besides poaching spears, the Margaree Salmon Museum contains legal tackle

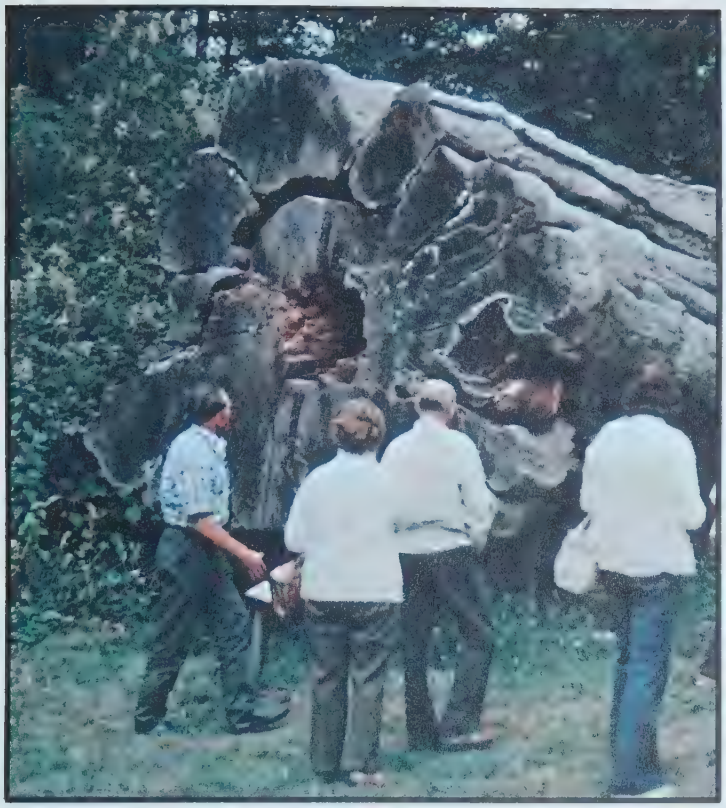
way No. 1 on Vancouver Island. It occupies 90 acres of lakeside, through which a 1½-mile-long, narrow-gauge railway carries visitors through canyons of towering Douglas firs, over hills and under bridges, and over a trestle high above Somenos Lake. The exhibits include a steam logging locomotive, heavy old wagons and buggies, Douglas firs five feet in diameter (100 years old when Captain Cook first set foot on the island in 1778), Indian totems, a water wheel and, in the log Museum Building, smaller tools and souvenirs of the province's logging industry. Retired lumberman Gerry Wellburn started the nucleus of the museum in 1949, with his collection of vehicles and equipment of the Canadian forest industry.

One of Quebec province's most unusual museums, right in the heart of Montreal, on historic Place d'Armes, is the Bank of Montreal's Head Office Museum at 129 St. James St. It is a reminder of how it was at Canada's first permanent bank in 1819, two years after it went into business.

Visitors almost literally step into the past when they enter, for immediately they are confronted from the cage by a smiling and mustachioed gent, the bank's first teller, Henry B. Stone. So warm is his smile that it may be an instant or two before they realize that he is only a dummy, and that even if they thrust their hands into his till he could

Stuffed salmon hang on the walls at North East Margaree, N.S., but the salmon museum there also includes demonstrations

Ronald A Woodill



Denise Mooney

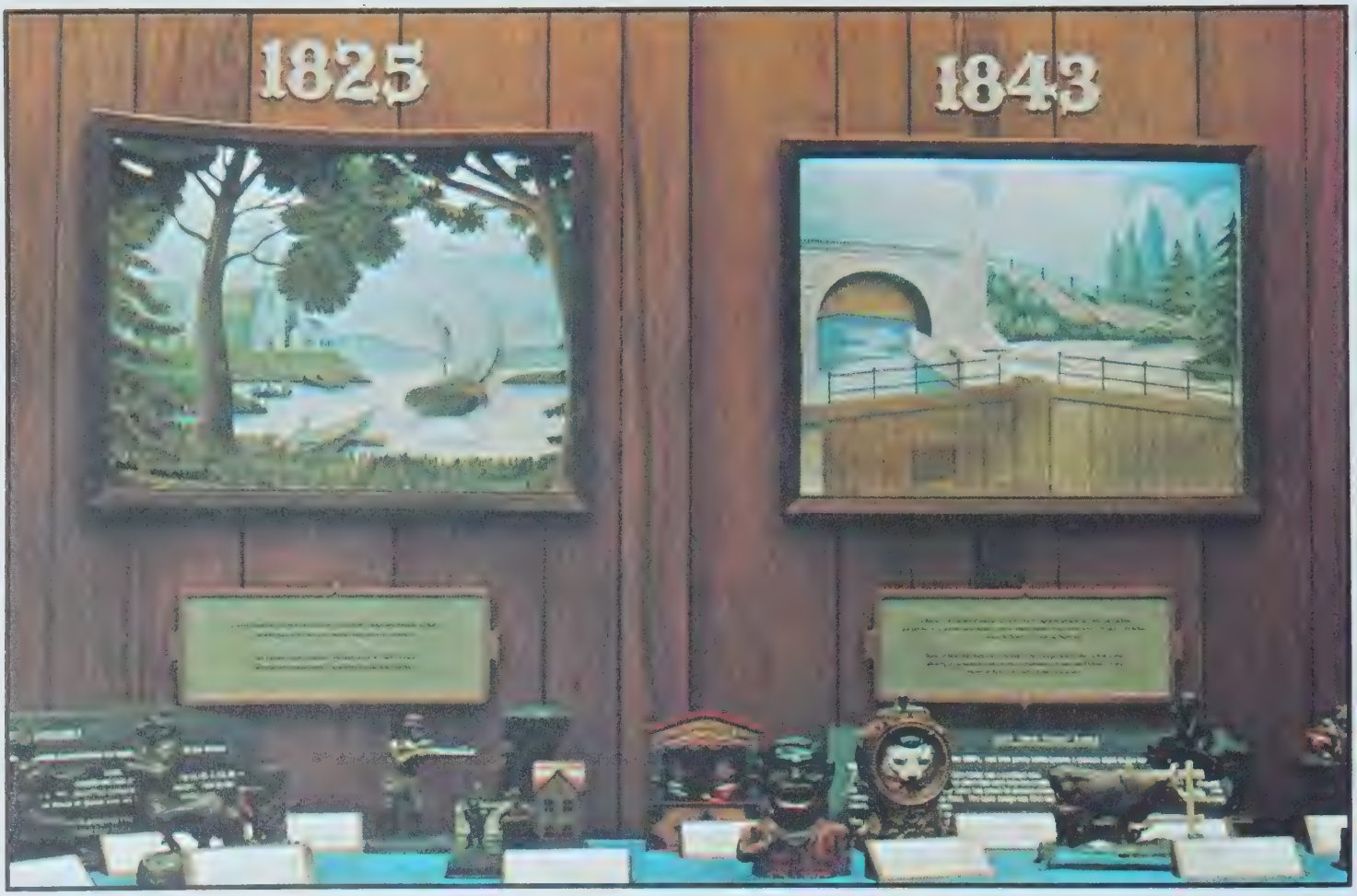
Enormous logs fascinate visitors to B.C.'s Forest Museum

Denise Mooney

Narrow-gauge railroad takes visitors for a 1½-mile trip

Part of the museum's rolling stock is this ancient steam locomotive, stopped here to take on water from the water tower

B.C. Government Photo



The Bank of Montreal's museum in Montreal contains a collection of cast-iron penny banks, many of them mechanically-actuated

When the hunter shoots a penny into the slot, a bear pops out of the stump

Drop a cent; the mouse becomes an acrobat

Henry Kalen

The main room of the house-barn in Manitoba's Mennonite Village Museum with guides in period costume

not raise the hand gun that rests on his counter. Henry B. has a quill pen and sharpener, too. The soft light from the simulated whale-oil lamps flickering on the walls, the dozey tick-tock of an ancient clock, the leatherbound customers' ledger, lying open to show the entries in pounds, shillings and pence – all these help to create the illusion that 1974 has telescoped backwards into 1819.

The museum contains tokens, coins, notes, documents and other mementos of the Bank of Montreal's early history including the original deed, hand written in 1648 by de Maisonneuve. In addition, a constant crowd pleaser will be on display throughout the summer. It's an assortment of 19th century penny banks. These cast iron 'toys' were designed to lure children to thrift: an inserted coin produced elaborate feats of movement from the finely detailed human and animal figurines.

Displaying more recent history the museum has a collection of documents, souvenir programs and medals produced to commemorate the September, 1901 visit of the Duke and Duchess of Cornwall and York, later King George V and Queen Mary.

Visitors flock to the Bank of Canada's $1,000 note often passing by a far more valuable prize – one of the two remaining $3 notes issued by the Bank of Montreal in 1844.

In every part of Canada are museums as special as these five and, generally speaking, as little known outside their own province or district. Their names can be obtained by writing to the ministers of tourism of the provinces. Inquiries should be made well ahead of time about admission prices, restaurants, parking arrangements and visiting hours – some of the smaller museums are open only in summer or on certain days of the week. □

Canadian Arctic Gas Study Limited

Replanting the Tundra

Special grasses can promote the development of new permafrost over a buried arctic gas pipeline

The northland is Canada's last frontier. It is sparsely populated, largely unexplored and only marginally developed. Its abundance of natural resources has been almost untouched. Vastness alone has held most of its secrets intact; climate and distance have kept away all but the most determined visitors. But the North is changing. Today, an expanded search for needed minerals and hydrocarbons has begun to unlock the region, revealing its treasures and shedding light on many of its mysteries.

In the last few years, gas discoveries in Alaska and the Mackenzie Delta have encouraged planning for a gas pipeline across the northern Yukon and southward up the Mackenzie Valley. Preparation studies for the line have produced some unexpected benefits. Out of a project aimed at a continued energy supply have come intensive bird, fish and mammal studies, research into the frozen ground known as permafrost and, just recently, one of the most extensive botanical investigations ever undertaken in the Canadian North. These efforts have been directed jointly by Canadian Arctic Gas Study Limited, and the universities of Alberta, Saskatchewan and British Columbia, to permit development and transportation of the region's natural gas.

But why a botanical study? Because

Seeding a test section of tundra over a buried gas pipeline at Sans Sault, NWT. For results a year later, see photo on page 31

Willow cuttings hand-planted to stabilize a slope

Northern Engineering researcher checks year-old grass growth

As part of an international tundra research program, the U.S. Tundra Biome Program studied the ability of various grasses to survive in the Arctic environment

after a pipeline is ditched through the forest and across the open tundra, the vegetative cover must be restored to prevent erosion. And in the Arctic there are two types of erosion to contend with – water and thermal. Water erosion is the kind common to most regions where rainfall and rivers wash away unprotected slopes and banks. Thermal erosion is unique to permafrost.

In both tundra and northern boreal forest, the existence of perpetually frozen soil requires a balance in the exchange of heat between air and ground. Where there are plants growing, they can form an insulating blanket that affects the flow of heat. If the insulating plant cover is removed and the soil happens to be laden with ice, the subsequent thaw and slumping process – called thermokarst – often creates a deep, water-filled trench.

Since 1970, Canadian Arctic Gas Study Limited has been trying to find a fast and effective way to restore the tundra's insulating cover and so prevent erosion. The Arctic Gas group of companies, of which Imperial is a member, has spent three-quarters of a million dollars on revegetation studies and expects to double the amount before its project is done.

To revegetate a pipeline right-of-way that stretches some 1,500 miles through many types of terrain is an ambitious task that requires not only money but also large amounts of information. Researchers working on the study have detailed both the landforms along the route and the wide variety of plant life that exists in each area.

Don Dabbs, head of the pipeline revegetation studies for Arctic Gas at Northern Engineering Services Company Ltd., explains the purpose of the research effort: 'By determining the plants that already exist in a region and then investigating their growth characteristics, we'll be able to select the appropriate plants for revegetation.'

To this end, Dabbs and his fellow workers – a group of soil, peatland and revegetation experts – have roamed the Mackenzie Valley and northern Yukon Territory filling notebooks and file folders with a multitude of data. 'This preparation for the pipeline, even if the line is never built, has brought more facts to light than would probably have been learned about the area in the next 10 years,' he said. 'The information is sound, biological data and it will be available to anyone who wants to use it.

Research called for precise examination of plants in carefully measured areas

Over the next two years all of it will be published in one form or another and some of it is already in print.

'I think it's fair to say,' he adds 'that Canadian Arctic Gas has made possible one of the most comprehensive ecological research projects in the Canadian North.'

Dr. Lawrence Bliss, professor of botany at the University of Alberta, believes the research program has added significantly to botanical knowledge of the North. 'Past efforts provided a base for this recent study,' he said, 'but much of the work carried out before was done in bits and pieces. The ability to study large areas and relate plant communities to topography, soils and animal use would not have been possible without industrial impetus.'

But what about the major aim of the study? Can the pipeline route be revegetated?

'We're certain it can,' says Dabbs. 'The tool for the task is a heavily fertilized mixture of well-known farm grasses, many of them relatives of grasses blanketing southern Canadian lawns. Creeping red fescue, Kentucky bluegrass and timothy are a few familiar names to be used in the seed mix. Right now seed merchants in the Peace River country of Alberta as well as Minnesota, Oregon and Washington are busy producing the one-and-a-half million pounds of seed needed to replant the entire route.

'The rationale for spreading the work around,' Dabbs explains, 'is to avoid a complete catastrophe in case disease or drought hits one of the areas. Using this method, there'll be enough seed to meet our needs when it comes time for the pipeline to go through.'

The farm grasses are the mainstay of the program and have proven themselves in mass seedings at abandoned drill sites, on old haul roads on the tundra and at separate test plots established by Dr. Bliss and Northern Engineering. While some of the grasses grow well for only one or two years, there are plans to include others in the mix that don't really catch on before one or two season's growth.

But the people at Northern Engineering agree that nothing would help the project more than some home-grown grass – the kind that is native to the tundra. Researchers have been working on two promising varieties that have shown

Canadian Arctic Gas Study Limited

Canadian Arctic Gas Study Limited

the desired qualities for revegetating disturbed surfaces. Says Northern's researcher Walt Younkin: 'These two grasses, called polargrass and bluejoint, are the first to get into exposed soil, whether it's from a natural frost heave or a man-made disturbance.'

Until recently, Younkin's work was part of the study being directed by Dr. Lawrence Bliss at the University of Alberta in Edmonton. The university's biological sciences building contains the most up-to-date facilities for controlled environment studies in Canada. Specially-built plant growth chambers can be set up to simulate the climate conditions

Two-season-old grass flourishes lushly over buried gas line at test facility located near Sans Sault, NWT

Second season's growth begins to show through matted stalks of grass seeded in June of the previous year

of almost any region on earth, from the tropics to the Arctic. During experiments, both in the northland and at the university, Younkin and fellow researchers identified polargrass and bluejoint as the most suitable for revegetation.

The problem with the grasses lies in finding enough of the seed to revegetate any significant area. The aim is for 100,000 pounds of the native stock to go into the mix and Dabbs thinks it's possible that this amount can be produced in the Peace River country. 'It will require much more basic research,' he said. 'And for the project to be practical we must be able to produce the seed on an agricultural scale.'

What makes these grasses so attractive is their fitness for the harsh Arctic environment. They are a natural part of the region's ecosystem and flourish as a result of thousands of years of selection. 'It is unlikely,' says Dabbs. 'that these species will be wiped out by disease or unusual weather conditions once they have become established.

'Though we hope to be able to use native grasses in the seed mix, it will be possible to maintain an adequate plant cover using only farm varieties,' says Dabbs. 'The native grasses will help reduce the amount of maintenance we have to do along the route. If we can't put together enough native seed by the time the pipeline is ready, we'll make up the difference with farm varieties. If some of the grasses in the mix die off, we'll simply go in and re-seed.

'By the time a pipeline is approved,' Dabbs said, 'we'll have enough seed to do the job. We'll also have enough for a second seeding in areas that don't take.

'In places that present re-seeding problems, like critical side slopes, we will help the grasses control erosion by hand-cutting and replanting. On slopes that erode easily, we intend to use soil-binding mats, staked down to hold things in place. In addition we've found that the tundra's vegetation can sometimes be stripped off, then replaced after the pipe is in the ground. With fertilizer and some extra seed a reasonable amount of it will re-establish itself.'

But for all their studies, the botanical influence of the Canadian Arctic Gas people will be temporary at best. Nature will soon regain control.

'Our work,' says Dabbs, 'is just a bandage to help nature heal itself. The revegetation program will keep things together until natural cover has returned.' □

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Imperial Oil Review

1974 NUMBER 4

Immerk, Adgo and Pullen

A firm of high-priced lawyers? No. They're islands built for oil and gas exploration in the Beaufort Sea

On recent maps of Canada's northern coastline, three mysterious dots have appeared in the Beaufort Sea. These dots, just north of the Mackenzie River delta, represent three tiny new islands, but they are not the result of any upheaval in nature. Rather they are the work of man in his continual search for new energy deposits. Imperial Oil has built them as drilling platforms from which to search for oil and gas.

This is desolate country. Ice prevails for more than nine months of the year. Temperatures may dip to 70 degrees below in the winter time. It is costly, difficult and even dangerous for men to work under such conditions. Why, then, has Imperial carried the search for petroleum into this frozen sea?

Put the question to Jim Park, Imperial's frontier planning manager, and he readily concedes that 'the normal trend of exploration is to do the accessible areas first.' But the easiest areas in Imperial's 10 million acres of permits in northern Canada have already been explored. Now, the focus must shift to the three million acres of permits that lie offshore.

In warmer parts of the world, most offshore drilling would be done from ships or floating barges anchored over a promising drilling site. But floating barges are useless where the sea is covered with five feet of ice for most of the year, and where ice floes from the north may invade the open water even during the brief summer.

'In the Arctic there aren't enough open-water days for a floating rig – maybe 80 days in the year,' says Park.

So in 1970, Imperial began the search for drilling methods possibilities. The company looked at steel structures that could be floated into place, but they were rejected as too costly. Ice islands were considered. So was the idea of floating in caissons and filling them with gravel, topped off with cement, for use as drilling platforms.

'But what we ended up with was the island concept, chiefly because of the economics of construction and its natural stability,' says Park.

Man-made islands had the added advantage of being safer and cheaper than the alternatives, at least in shallow water, and in the Beaufort, shallow water extends offshore for miles. Even 25 miles out, the water may be only 60 feet deep.

The Beaufort Sea is already dotted

Tom Watmore

Adgo, in water only seven feet deep, was the second well drilled from an artificial island in the Beaufort Sea. It discovered oil and gas

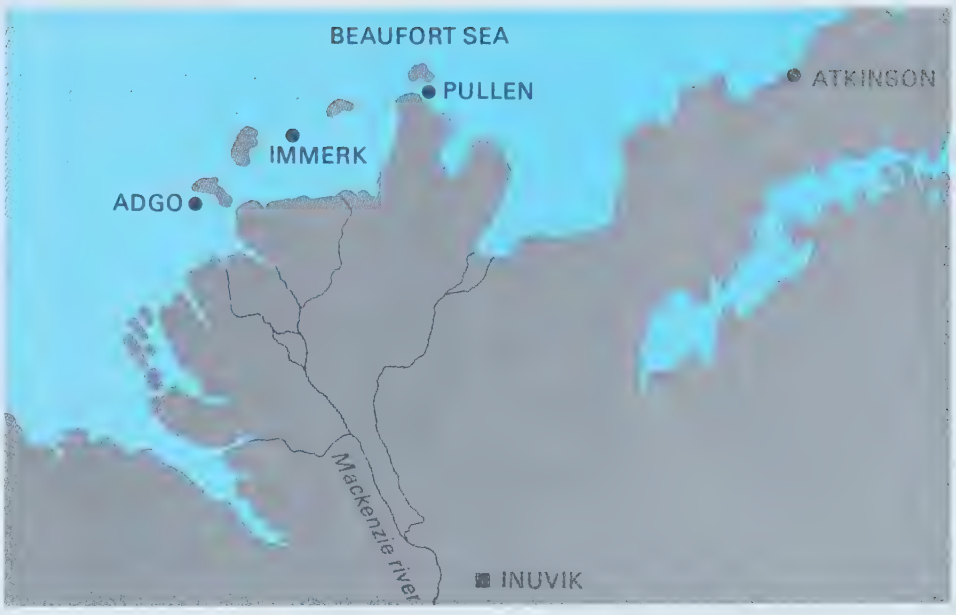
Imperial spent $9 million building and drilling Immerk, the first artificial island, but the well was abandoned at 8,883 feet because of high pressures

The building of Pullen Island involved a convoy of 30 trucks that worked continuously to bring 80,000 yards of gravel from 67 miles away

with many natural islands, but nature did not spot them for the convenience of oil companies. Most are not over promising geological structures. Apart from the islands in the Mackenzie Delta, one well has been drilled from a natural island.

Imperial has built three islands so far in its offshore search – Immerk, Adgo and Pullen. Each has been built in a different way as the company seeks the most efficient and economical method of construction.

Immerk was first. Its original design, drawn up by a Vancouver engineering firm, was relatively simple. Gravel would be dredged from the sea bottom less than a mile from the site and piped to the location. There it would be piled up in the water, which was only 10 feet deep.



Tom Watmore

Adgo Island is washing away, as planned. As the silt thaws, the island is gradually eroding into the sea from which it came

The plan called for 400,000 cubic yards of gravel – enough to cover a football field to a depth of 200 feet. The goal was to create a working platform 300 feet in diameter and 15 feet above the sea's surface.

Work began in the summer of 1972 with the establishment of a floating work camp for 60 men. But complications developed almost immediately. First, the gravel on the seabed proved to be coarser than tests had indicated, cutting almost in half the rate at which it could be pumped to the site.

Even worse, the weather rebelled. In the Arctic, they talk in terms of 10 or 20-year storms – storms of a ferocity that strike only once in 10 or 20 years. That summer, says Park, there were three or four 20-year storms.

The construction schedule was changed and the rest of that summer was devoted to completing a basic structure just big enough to permit measures of island stability, environmental effects, and ice movements.

When work resumed in the summer of 1973, calculations showed that not enough gravel could be pumped to finish the island before the summer's end, so a substitute plan was devised. Originally, specifications had called for wide beaches which would not be easily eroded. Now, the company decided to substitute steeper, narrower slopes. To keep them from washing away they would be reinforced by layers of plastic mesh and war-surplus anti-submarine netting. That meant less gravel would be needed and completion would be possible by the end of summer. By mid-August, Immerk was ready for the first drilling equipment. About $5 million had been spent on the island's construction.

The drill began turning in September, with plans to go down to 15,000 feet. But at 8,883 feet the well was abandoned because of high formation pressures. Total cost of Immerk and the well: more than $9 million.

Even before Immerk had been completed, however, Imperial had begun work on its second island, Adgo, experimenting with a different concept. It was late summer and a combination of gravel and silt was being used. The theory, says Gordon Willmon, Imperial's frontier operations manager, was that as winter closed in, the silt would freeze, forming a solid base. Located in water only seven feet deep, Adgo was intended for winter drilling only.

'We wanted to build a drilling platform that we could use during the winter when the island was frozen, recognizing it would be washed away by spring breakup and summer wave action,' says Willmon.

Adgo was a rectangular island, 150 feet by 600 feet, surrounded by a gravel dike and protruding three feet above the water. The centre was filled with silt, with a gravel pad in the centre for the drilling rig. Its cost was only $2 million.

When the drilling began from Adgo, Imperial's luck changed. The company announced on March 13, 1974, that oil and gas had been found. The well was tested and plugged, and the rig was moved to shore over the ice before breakup.

'Our next job will be to find out the extent of the deposit by drilling some more wells,' Willmon says.

Adgo is washing away now, as intended. As the silt thaws, the island is gradually disappearing. Permanent islands will be built for the future producing wells, perhaps on Adgo's site, perhaps elsewhere.

Imperial's third island, built by still another technique, was prepared for exploration activity last winter. Pullen Island was created in bitter weather and under considerable pressure of time. A ditch digging machine with the buckets replaced by blades, something like a gigantic chain saw, was used to cut through the five feet of ice covering the sea. When a hole 225 by 375 feet had been opened up, gravel was poured into the 5.5 feet of water welling up into the opening. A convoy of 30 trucks brought 80,000 yards of gravel from a gravel pit 67 miles distant, hauling continuously for a month. When the ice goes out, Pullen will sit eight feet above the water and will be suitable for drilling over the spring/summer period.

Willmon and Park admit that Imperial has been learning a lot about island-building as it goes along. For the fourth island, Netserk, to be built this summer, the company will return to the basic design used on Immerk, with some modifications to protect the slopes from erosion, Park says.

Imperial has been gathering information from its three islands through a battery of sensors and monitoring equipment wired into them. These include instruments to measure the ice pressure, slope indicators to check on island movement, monitors to detect settling, and probes to determine the spread of permafrost into the islands.

Some valuable data has been acquired. Park says oceanographic surveys are being carried out to more accurately predict the frequency and strength of wave action on the islands.

Imperial has made application to build a fifth island and will have the capacity of building three a year. Whether the program will proceed at that rate depends on continued exploration incentive: the discovery of petroleum reserves from the test holes and favorable government actions.

'This whole program is so darn dependent on dry holes and successes,' Park says.

If a field worth developing is discovered, more permanent islands will be built, but they need not be much bigger than the present ones, Willmon says. A permanent island 300 to 400 feet in diameter – much the same size as Immerk – could be used to drill 15 or 20 wells. The drills would angle to the side, rather than going straight down, so as to cover a larger area. A small field could be drained from one island, says Willmon; a large one might require four or five.

Naturally, the effect of the program on the Arctic environment has been a major concern. Imperial commissioned two environmental and ecological studies in 1972 and 1973 to determine the effects of plunking artificial islands down in the Beaufort Sea. Research has been carried out not only on fish and organisms that live on the ocean floor, but on the white Beluga whales that inhabit the region.

'The major fear was that the island would interfere with the migration or calving of the whales which the natives depend on for hunting purposes,' says Park. 'Nobody had ever studied them properly so we had to do some pretty basic research.

'They seem curious,' says Park. 'A few of them come close to the equipment and the steady noise of the dredge doesn't seem to scare them.'

The Belugas are much more fearful of hunters, he says, and will run from any fast boat. Boat traffic is restricted when the 17-foot whales are in the island-building area and federal regulations require observers to watch for them.

The study of 1973 was carried out from June to August, the period when

Huge blocks of ice, weighing 7 tons apiece, are lifted carefully from the frozen sea by the machine known as a cherrypicker

Bitter weather and pressures of time attended the building of Pullen. Machines cut through five feet of ice covering the sea for this latest island

Imperial Oil Limited

whale activity and hunting is most intense. Some 3,500 to 4,000 whales were sighted, and 177 animals were taken by the Eskimo, 64 more than the previous year. Although dredging was taking place during the month of July, large groups of whales (200-400) were observed moving past the island during the dredging operations.

The reaction of the local people to the islands has been generally favorable, too, says Park. They have made up about half the work force on the three islands and 'local people are very appreciative of the work done,' he says. In fact, there seems to be a sentiment among the locals that they'd like to see the islands stay after drilling is completed. 'They're convenient to whale or fish from.'

That, however, will be up to the federal government. The government has been involved every step of the way from the initial granting of permits to build the islands, down to the final cleanup after work is completed.

Immerk could last indefinitely with proper maintenance, says Park. For the time being it is being used as a storage platform and equipment base and will probably be used as a landing station for some time. Even if abandoned, it would remain above the water for about 10 years.

The stakes are high for Imperial in the Beaufort Sea. It costs at least twice as much to drill an exploratory well from an island as from onshore. The company needs to hit the jackpot to recover these costs.

'There's no doubt that with the much higher costs we've got to be looking for the bigger prize,' Park says.

It's a drastic change from 1964, the year Imperial obtained the first northern exploration permits. At that time, some oil men couldn't see that it made much difference whether there was oil and gas in the Arctic or not.

'People thought it was crazy,' says Willmon. 'Oil and gas prices were such that it would never be economic to develop.'

It doesn't look so crazy now. Since then, Imperial Oil has spent more than $100 million on northern exploration permits. Just last winter, another company followed Imperial's lead by building an offshore exploration island. Immerk, Adgo and Pullen may be only the first of many new dots on maps of the North. □

This 125-year-old Brantford clock has a case made of cherrywood and birdseye maple

The dial of this 19th Century Quebec clock has maple and butternut wood inlay

TIME WAS

The short, bittersweet saga of Canadian clock-making

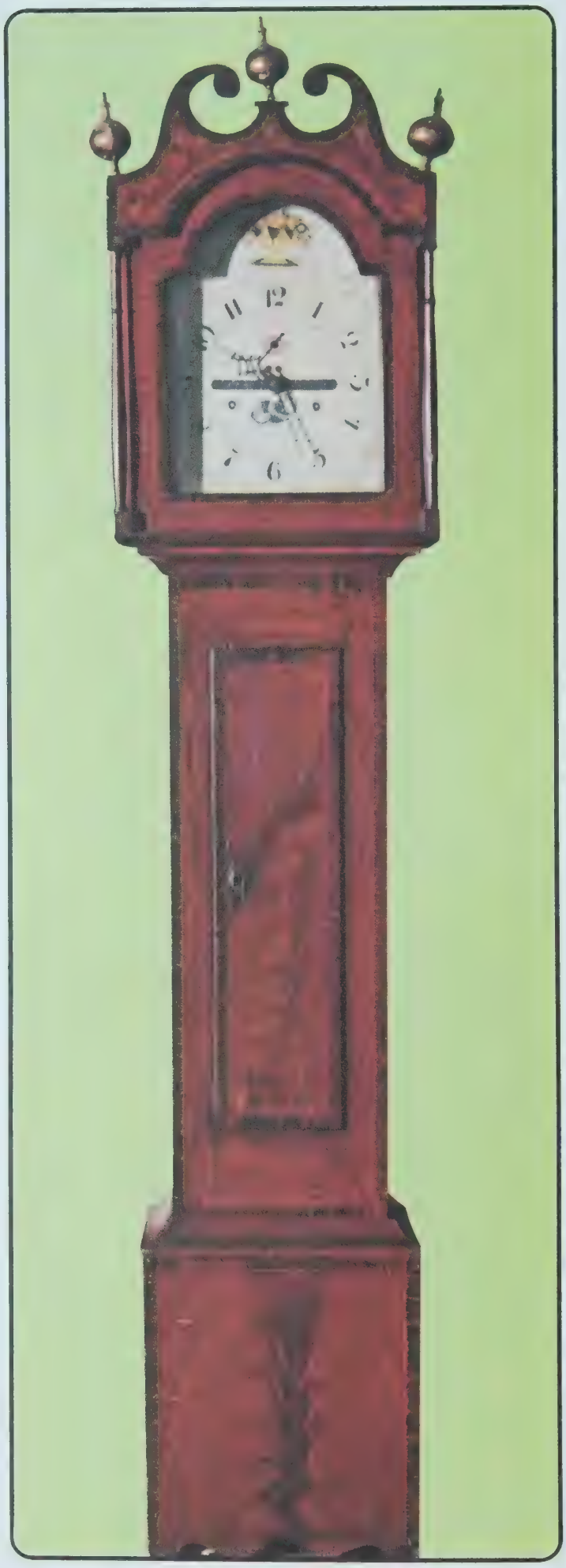
by Patrick Conlon/photos by Barry Dursley

If the current enthusiasm for Canadiana had its own star system, Canadian clocks would be right up near the top alongside pine and bottles and lamps. But clocks are much more scarce.

The chief reason is that they were never produced in substantial volume and consequently weren't as common in their own day as pine and the other collectables. During the 19th century there didn't seem to be any sense in trying to establish a clock industry here: by the time Canada was beginning to enjoy some sense of national unity, American clockmakers had become acknowledged world leaders in the field. Mass production of clocks had originated in the United States and thousands of American brands were being exported to Canada every year. These clocks were reliable and inexpensive, and Canada was a profitable market for American companies like Ansonia, Sessions, Seth Thomas, New Haven and Waterbury.

Despite all this, there were two attempts to mass-produce clocks in Canada, using all-Canadian labor and materials: The Arthur Pequegnat Clock Company and The Canada Clock Company. The former was successful and the latter wasn't. In the gap between their products and identifiable American imports lies a long list of clocks that are not exactly one thing or the other.

For instance it was common practice in the 19th century for many Canadian clockmakers with limited production facilities to import the movements for their clocks from the United States and then fit them into Canadian-made cases with suitable decorations like the British coat-of-arms to give them a Canadian flavour. Wealthy citizens of New France had their clocks made locally of pine, using movements imported from France. Often, too, Canadian jewellers not actually engaged in clockmaking would buy clocks from American makers, 'Canadianized' with pasted-on labels that bore the jeweller's

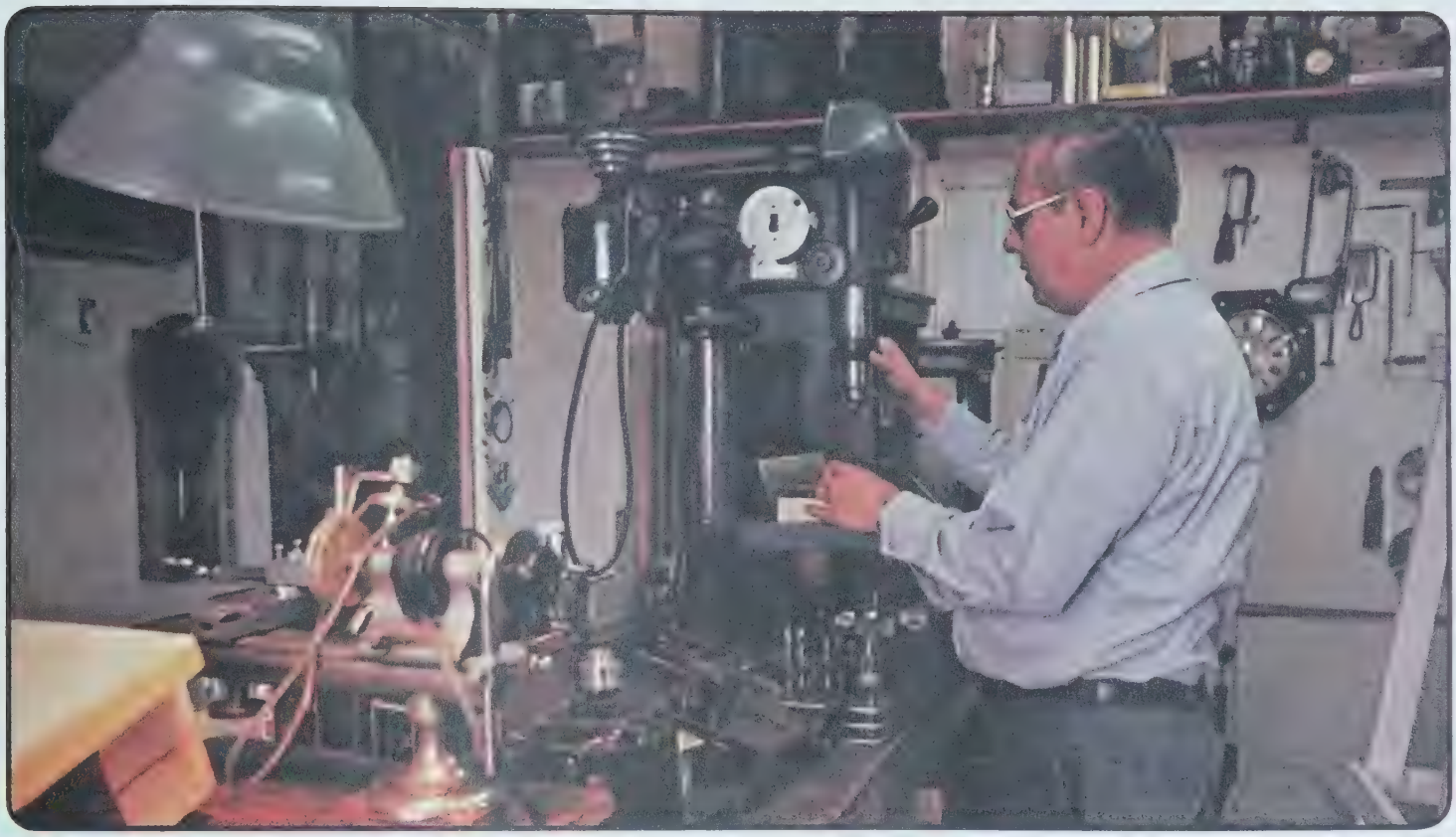


Made in Montreal in 1830, this longcase clock (above and at right) is of pine, with the typical handpainted finish that the Twiss brothers gave to their clocks

name and that of his village or town.

One of Canada's first travelling clock salesmen was Moses Barrett, a genuine eccentric who apparently inspired Judge Thomas Haliburton to create his famous Sam Slick. Barrett was born in Connecticut, the heart of American clockmaking, and later settled in Amherst, Nova Scotia, where he built a profitable clock business. He would fashion the elaborate cases for his clocks during the winter months and use movements imported from the United States. Then, in late spring, he would load his wagon and set out through the Nova Scotia countryside accompanied only by his cat. Not content merely to sell a clock, Barrett invariably had a gossipy tale or a chunk of folksy wisdom for each customer, and he quickly became a welcome annual visitor to the villages on his route.

Connecticut also sent to Canada the five Twiss brothers, who set up a branch plant organization in Montreal in 1821 specializing in grandfather clocks. In order to compete with imported English and Scottish grandfather clocks, they developed a unique method of finishing their cases that was both economical and attractive. Each case was constructed entirely of pine – then in plentiful supply – and meticulously handpainted to simulate the fine veneers and elaborate marquetry that people expected in a grandfather clock. The effect was startlingly real and it allowed the Twiss brothers to undercut



Robert Phillip, whose Museum of Time is located in Cookstown, Ontario, sometimes rebuilds clocks almost from scratch

The Winnipeg was made in Berlin, Ont., between 1910 and 1914

Phillip rebuilt this Pequegnat, with its Empire-type finial

'Baby gingerbread' design decorates this carved walnut case, only 10 inches high and six inches wide

Although the dial reads M.S. Brown and Co., Halifax, the case may have been made in Paris, London or the U.S.

their competition substantially. Peter and Doris Unitt, co-authors of several Canadian antique price guides, warn that the current value of a Twiss clock diminishes considerably if its original finish is stripped.

During the same period, Joseph Balleray of Longueuil, and C.J. Ardoin, of Quebec City, were turning out clocks with dials sporting floral and geometric designs, sometimes signed by outstanding artists such as Cornelius Krieghoff.

The first Canadian factory to mass-produce clocks was The Canada Clock Company, founded in Whitby in 1872 and later renamed The Hamilton Clock Company after moving there in 1876. Under a former lumber salesman named John Collins, the company started manufacturing Canadian versions of popular American clock designs and claimed a monthly production capacity of 5,000 clocks. Whether or not this figure was ever achieved is now a matter of conjecture because there are no existing sales records and the business quietly folded in 1886. These clocks are now extremely rare, a fact that may be a key to the numbers actually produced.

This 'looking glass' clock was made in Dundas, Ont., and is marked Upper Canada 1841

Canadian design was sometimes more baroque than beautiful, as evidenced by this Pequegnat clock

A Pantheon clock made by Pequegnat was apparently modelled after a Greek temple

Canadian clocks clustered on the wall of the Phillip Museum of Time show similarities of design in their cases

The second attempt to mass-produce clocks in Canada was considerably more successful.

Arthur Pequegnat (pronounced Peginaw), a Swiss immigrant and clockmaker, opened The Arthur Pequegnat Clock Company in Berlin (now Kitchener), Ontario, in 1904 with an aggressive campaign that appealed directly to Canadian nationalism. His idea was to produce a range of totally Canadian clocks and sell them at prices competitive with American brands. Canadians apparently took to his clocks immediately, because his enterprise flourished until a Second World War brass shortage forced the company to close in 1941. These days, Pequegnat clocks are highly desirable because of their uniquely Canadian quality. Pequegnat produced more than 90 different types of clocks, ranging from kitchen clocks to precise railway station timekeepers, but they rarely turn up in antique shops. Perhaps many of them simply haven't emerged from attics or basements yet – or perhaps they've been passed down through families who are now reluctant to part with them.

'Canadian Clocks and Clockmakers' is the only book available to the shopper interested in distinguishing between American, 'almost Canadian' and truly Canadian clocks. Written by Edmond Burrows, an Oshawa accountant and clock collector, the book gives brief histories of the important Canadian clockmakers and is illustrated with photographs of their clocks. □

Shorelines

by David Parry

Montreal-bound oil tankers sail past some interesting places, Sarnia, Sandwich and thousands of islands.

Alec Burns

Scarborough Bluffs, carved by wind, water and time, form part of the shoreline followed by the route of the big tankers

Of all the world's liquids, which one would you guess has inspired man the most? Forget the wine lists and brandy catalogues. The answer – straight up – is water. That's right, the same colorless stuff that soaks our lawns, cleans our cars, unstiffens our drinks, and wears out our eaves. But get enough of it together to fill a river or lake, and water can also move those who inhabit its shores to levels of creativity, bold thought, and outright curious behavior, the likes of which is rarely seen in land-lubber locales.

It was water, after all, that inspired humanity to such diverse achievements as the marathon swim, the atomic submarine, dog derbies, bikini swim suits, hydroelectric power, concrete canoes and the snorkel. In Canada, we've used our waterways for exploration, confron-

Bill Brooks

tation, recreation and transportation. Recently, when it became necessary to replace curtailed supplies of imported crude oil, large lake tankers began hauling western Canadian crude oil to eastern refineries. Those places they pass along the route have seen some of the more amazing and amusing moments in Canadian history.

Sarnia:
Off from a Rapids' start

In 1836, Sarnia was little more than 44 taxpayers, a few frame houses and two pubs. It was known as The Rapids. Residents wanted a name change, but couldn't make a choice. Sir John Colborne, Government General of Upper Canada, urged them to select 'something impersonal and significant.' Such as? Sir John's 'impersonal' choice was Port Sarnia, after the original Roman name for the Isle of Guernsey – his previous posting.

In the mid-1840's, a Scottish stonemason and builder arrived in Sarnia and became editor of the Lambton Shield, the county's first newspaper. The reformist Shield gave an exuberant roasting to a local Tory cabinet minister who sued for libel and won. It forced the paper to fold. The editor, Alexander Mackenzie, ran for office himself and later became Canada's second prime minister.

When oil was found nearby, Sarnia took to refining. Crude oil was carted from the wells over plank roads. Sometimes it was sealed in barrels and floated log-style down Big Bear Creek to ships in the St. Clair River. North America's first oil pipeline ran between Sarnia and Petrolia, about 12 miles away.

Sarnia's growth as a refining centre made it a logical terminus for later pipelines from Texas and Alberta. It's Alberta crude that is transferred here into tankers for the four-day trip to Montreal.

Windsor:
Americans, come on down

Visitors from the U.S. are often surprised to find that in crossing from Detroit into Windsor, they drive south. With car ferries, a suspension bridge

Six square miles in area, arrow-shaped Point Pelee has space for pecans, oranges, cotton and many varieties of birds

and two tunnels (including an auto tunnel almost a mile long), Windsor is Canada's busiest border community. There are almost as many crossings made here each year as there are people in Canada.

But the border was a lively one long before now. Up until the time of the American Civil War, slaves were smuggled into Windsor via the Underground Railway. In later years, the smuggling operations moved in the opposite direction as Windsor-based rum-runners scooted their wares across the river to an eager market parched by Prohibition.

The Windsor area was first settled by French pioneers who arrived shortly after a fort was established at Detroit in 1701. They laid out their farms in narrow strips along the river, like those on the St. Lawrence. The region first developed as a suburb of Detroit. For example, the town of Sandwich, now part of Windsor, used to be called South Side, in reference to Detroit, farther north.

Sandwich, Windsor, East Windsor and Walkerville were known as the Border Cities until they amalgamated in 1935 under the name of Windsor. Walkerville had been originally named after the distiller who started his business there. For East Windsor the name change was the second in six years. Until 1929, it too had been named for one of its major businesses, Ford.

Amherstburg:
Everyone's battleground

Few communities of any size have known such a history of hostility as this little town, 16 miles south of Windsor, near the end of the Detroit River at Lake Erie.

Ironically, the first white inhabitants were missionaries on Bois Blanc Island, just offshore from the present townsite. When the Americans took over Detroit in 1796, the British came downstream and built Fort Malden where Amherstburg stands today. Military outposts went up on Bois Blanc Island, and United Empire Loyalists soon quit Detroit for the land around the new fort. Here, in 1812, General Isaac Brock and the celebrated Indian chief Tecumseh plotted their successful invasion of Detroit. But the Americans counterattacked and took over the remains of Fort Malden. The defenders had put it to the torch on their way out.

In 1839, the fortifications of Bois Blanc Island had to be rebuilt once more, this time to guard against supporters of William Lyon Mackenzie. The year before, a rebel schooner, Anne, had fired on the Canadian shore near Amherstburg. But the boat ran aground and her crew was captured by the local militia.

The town even became briefly involved in a completely non-Canadian

Welland Canal's first locks in 1840 were 110 feet long, 22 feet wide and 8 feet deep. Today's dimensions are 800, 80 and 30

Bill Brooks

The Shaw Festival gave new life to Niagara-on-the-Lake, but its continuing appeal lies in its old houses and gardens

conflict. During the U.S. Civil War, a band of Confederate sympathizers climbed aboard the American steamship, Philo Parsons, while it was docked at Amherstburg. Other Confederates got on at Sandwich and the two groups seized control of the vessel.

Fort Malden is now a national historic park and some of the old fort's original earthworks are still there. But Bois Blanc Island has since become 'Bob-Lo' Island Amusement Park. In today's quieter times, the residents of Amherstburg process tomatoes, manufacture soda ash and work on the Great Lakes boats.

Niagara Falls -- honeymoon hotels, Houdini's hideaway, the Rainbow Bridge. And the magnificent Falls themselves

Point Pelee:
Ontario's Deep South

A memorial plaque here records an incident in 1845 in which two steamships on collision course sighted each other in time to avoid collision, but both refused to give way. One ship was damaged, the other sank.

And should anyone believe proximity to water brings out unusual behavior only in homo sapiens, consider some of the goings-on at present-day Point Pelee, the skinny jag of land that shoots out into Lake Erie, six miles south of Leamington. The climate is warm enough here to grow pecans, oranges and cotton. Over 350 varieties of birds, from broad-winged hawk to Carolina wren, pass by on migration or live here.

Point Pelee lies on the same latitude as southern Corsica or northern California. Since 1918, the six-square mile area has been preserved as a national park. It's perfectly suited to the purpose, with some 40 miles of beaches and a nature trail that threads through rich stands of red cedar and black walnut.

Welland Canal:
The Great Lakes great leveller

The present shipping route between Lake Erie and Lake Ontario is the latest of four Welland Canals. The first, completed in 1829, had wooden gates and a maximum depth of eight feet. No less than 40 locks were needed (today's canal has eight) to make up for the 326½-foot difference in elevation between the lakes.

The second canal progressed to stone locks, some of which can still be seen on the abandoned route near St. Catha-

rines and Thorold.

From its beginnings, the Welland Canal has evoked strong feeling – not all of it favorable. When the government was asked to provide financial support, William Lyon Mackenzie called the scheme, 'a hoax from the start to last' claiming that 'Economy and the Welland Canal are as far apart as earth and heaven.'

But opinions changed and by 1866 the Welland Canal had become so successful that Fenian raiders considered it a choice target for attack. Their plan was to seize the canal and hold it until Queen Victoria met Fenian demands in Ireland. The scheme, though it failed, served one worthwhile purpose by illustrating how vulnerable the Canadian provinces were to outside attack. This helped encourage a speedier approach to Confederation.

The extensive reforestation along the banks of the canal is more important than it may seem. For while the tree roots help hold the soil together, cutting down on erosion, ecology isn't the only reason they are there. The trees also help screen cross winds, which can slow down travel through the locks.

If you've ever wondered what happened to the original Welland River, it's still there – underground. It runs below the canal in half a dozen concrete tubes.

Niagara Falls:
Not easily 'mist'

Had the Dundas Valley not clogged up with ice and debris during the Ice Age, Lake Erie might still drain through that route as it once did. Instead, it was forced to push its way through the Niagara River 10,000 to 12,000 years ago, creating one of the most spectacular sights on earth.

The Niagara Falls suspension bridge, above the start of the Whirlpool Rapids, became almost as big an attraction as the Falls themselves when it opened in 1847. One puzzle for the builders had been to make the initial link across the 700-foot gorge. Inspiration triumphed. A kite-flying contest was announced, with a prize to the first boy who could land his kite on the opposite bank. A New York State youngster, Homan Walsh, pocketed the prize, said to be five dollars, but possibly higher. To Homan's first slender kite string a heavier cord was attached and gingerly drawn across the gorge. Once this connection was made a heavier rope was tied to it and pulled across. The procedure continued until wire cable joined both banks. The bridge, though it has been substantially modified, survives today.

Niagara-On-The-Lake:
Town with a past

Ontario's oldest community and first capital of Upper Canada sits in picturesque relaxation at the mouth of the Niagara River by Lake Ontario. Since 1792, the town has been variously known as Newark, West Niagara, Lennox, Butlersburg, Oniagara, Niagara, and finally – to avoid mix-ups in the post office – Niagara-on-the-Lake.

Fort George, once the area's main hope for defence, proved sadly inadequate in the War of 1812. When the British withdrew under enemy attack, they demolished the fort. It was partially rebuilt during enemy occupation, but abandoned at the end of the war in favor of the more suitably planned Fort Mississauga. Fort George has since been restored.

Niagara-on-the-Lake has switched between prosperity and grim times almost as frequently as it has changed names. It thrived until the routing of the second Welland Canal gave St. Catharines handier access to shipping. Near the end of the last century, Niagara-on-the-Lake flourished once again as a summer resort, linked by rail and electric tramway to other towns, and a regular port of call for lake steamers. But the arrival of the automobile led to the development of other recreational areas, and business waned once more.

Today, Niagara-on-the-Lake is again

Presqu'ile Point Park has beaches, sand dunes and marshes teeming with bird life

Bill Brooks

Malak/Miller Services

The Thousand Islands (actually there are several hundred more than that) lie sprinkled on the water like nuts in a Waldorf salad

a popular place for visitors. People come to see the Shaw Festival and Canadian Mime Theatre. But the continuing appeal lies in the town itself. Delightful old buildings have been impeccably preserved and restored, not only as showpieces, but as permanent homes and places of business.

In 1909, a land survey revealed that many of the older houses were so close to the street they encroached upon the 66-foot road allowance. Later home owners, building between these older houses, preferred larger front lawns. The result: some of the most charmingly irregular streetscapes to be found.

St. Catharines:
Girl Guides and electric trains

At the eastern end of the Welland Canal sits 'Garden City,' which claims, among other items, North America's first electric streetcar system, Canada's first school of nursing, and first Girl Guide group.

Lakeside Park in Port Dalhousie (which is now part of St. Catharines) was once run as an amusement park by the C.N.R. along with the Canadian National Steamship Company, which made regular runs from Hamilton and Toronto. One of the two steamships burned in 1948. The other was sold. But Lakeside Park, now operated by the city, lives on. Near the parking lot sits a small building which was once the Port Dalhousie Gaol, which may have been one of the cheerier places in its day; both cells came complete with an open fireplace.

Kingston:
Where Dickens took to the pen

At the opposite end of Lake Ontario, a larger prison was built on a well-treed shoreline west of town. When Charles Dickens visited Kingston in 1842, the efficiency of this penitentiary was one of the few favorable comments he had to make about the city, which was then the capital of the United Province of Canada. Two years earlier, a fire had razed 150 of Kingston's buildings. In Dickens' words, 'One half of it appears to be burned down, and the other half not to be built up.'

Kingston was linked to Ottawa by the Rideau Canal at the urging of no less an authority than the Duke of Wellington. The 'Iron Duke', who had turned his attention from Waterloo to waterways, wanted Canada to have a safe route to the east away from the U.S. border. Work on the canal began in 1826.

One of Kingston's more conspicuous early homes was a huge Italian-style limestone mansion built by a prominent food merchant, Charles V. Hales. Mindful of its owner's line of business, residents nicknamed the house 'Pekoe Pagoda' and 'Tea Caddy Castle.' When Kingston ran into economic trouble af-

Malak Miller Services

Upper Canada Village has been so meticulously reconstructed it almost makes our past become our present

ter the capital was moved to Montreal, Hales decided to rent the place out to tenants. In 1848, the extravagant trappings attracted an image-conscious young politician, John A. Macdonald, who lived there briefly until setbacks in his legal practice forced him to seek more modest quarters. Bellevue House, as the home was called, was bought by the Federal Government in 1964 as a national historic park.

Thousand Islands: Who's counting anyway?

If you've ever suspected the name is an exaggeration, surprise! It's an understatement. There are about 1,800 islands here, most on the Canadian side of the border. They range in importance from bare rocks peeking through the river to acreages large enough to farm. The islands, which stretch 50 miles along the St. Lawrence between Kingston and Brockville, were the setting for James Fenimore Cooper's novel, The Pathfinder.

Although the Thousand Islands have long attracted visitors, few have shown the enthusiasm of George Boldt, once operator of New York's Waldorf-Astoria Hotel. Boldt invested $3 million in a Rhine-style castle on Heart Island near Alexandria Bay. But he died in 1916 before the 11-building complex was completed. The castle has since been abandoned by all except wildlife and curious passersby.

Upper Canada Village: A flood of history

One part of the St. Lawrence Seaway project was to get rid of the Long Sault Rapids, which had always been a serious obstacle to shipping. The solution was to raise the river. This not only buried the rapids, it also wiped out all or part of eight villages; some 6,500 people had to be moved.

One other result was Upper Canada Village, a collection of more than 40 buildings removed from the path of the flood. Each is typical of an early St. Lawrence settlement. Mills, homes, churches, and taverns were carefully relocated and appropriately outfitted for their time between 1785 and 1860. Even the flowers, vegetables and landscaping were chosen for their historic authenticity.

Oxcarts and bateaux of a bygone age still ply the lanes and narrow canals at Upper Canada Village, while a blacksmith shop, baker, and woollen mill show how skills were practised years ago.

The stages of living standards that a

Horst Ehricht

Montreal, with its futuristic underground city, makes a glittering end to a tanker's trip

typical pioneer family might have known are demonstrated in the buildings of the village. First requirements were for shelter – any shelter. This usually meant a log shanty, a rough shack representing no more than a few days work, and often without windows or chimney. First priority was to clear land and raise crops. More comfortable log houses would follow, and eventually, perhaps, a 'third-phase' dwelling, such as the fieldstone house preserved at Upper Canada Village. The house has a sophisticated heating arrangement that used stoves instead of fireplaces. A mechanical dumbwaiter lifts food from basement storage rooms to kitchen.

Caughnawaga:
Home of the high-steelers

On the St. Lawrence River's southern shore directly across from Lachine, sits the Caughnawaga Iroquois reservation. It began as a Jesuit mission in 1668. By 1732, the Indian population had grown to 900, including 250 warriors. Though they fought on the side of the French in the Seven Year's War, the Caughnawaga Iroquois were allies of the British in the War of 1812. And when rebels launched a raid on their community during the Rebellion of 1837-38, the Indians captured their attackers. Queen Victoria had gifts sent in appreciation.

Though Caughnawaga Indians excelled as voyageurs and river pilots, they have been demonstrating a much different skill since 1885: high construction work. That was the year a number of them signed on to help build a bridge to Lachine. Their unusual ability to work at great heights was recognized immediately, and soon Caughnawaga Indians were in demand for tall buildings throughout North America. When the Quebec Bridge collapsed under construction in 1907, the tragedy was especially felt in Caughnawaga: 33 tribesmen were killed.

Montreal:
Mountain of the River

Just over the bridge from Caughnawaga lies an island 32 miles long and 10 miles wide. It has over 5,000 restaurants, North America's only city built around a forested mountain, and one out of every 10 Canadians. After Paris, Montreal's French-speaking population is the largest in the world.

When Jacques Cartier arrived in 1535, he found the area inhabited by about a thousand Huron Indians who called their settlement Hochelaga. Just over a hundred years later, Paul de Chomedey, sieur de Maisonneuve, built a tiny village on the site and named it Ville Marie.

As governor of Montreal, Maisonneuve administered an effective, if unusual, style of justice. One of the great scandals of the day was revealed in 1660 when a wealthy trader, Jean Audubon, was convicted of improper conduct with the wife of the village's first surgeon. Maisonneuve fined the trader and banished him from the village. To the erring wife's husband he assigned the right to keep her 'locked up for the rest of her life, or give her back to her father and mother.' The surgeon decided not to give her back, and the marriage survived. Even Audubon was able to return to respectability. He had his banishment revoked and later became a warden of the church.

The nearby Lachine Rapids and Saint Mary's Current barred all but the most nimble craft from travelling past Montreal up the St. Lawrence. Canals and locks later provided a way through, but they weren't large enough for ocean-going ships. Thus goods were transferred back and forth from vessel to vessel and Montreal enjoyed a lively harbor trade.

Though some Montrealers feared the St. Lawrence Seaway would hurt business in the harbor, port activity increased rather than declined. Adding to the traffic this year will be the crude oil tankers, winding up their voyage past some of Canada's most colorful waterfront land. □

The Energy Crisis That Wasn't

Last winter's fuel shortages created problems throughout the world, but Canada remained virtually untouched. How come?

The unimaginable seemed about to happen late in 1973. Canada – a country that produces 2 million barrels of oil per day and uses only 1.8 million – appeared to be on the brink of a petroleum shortage.

How could such a thing happen? How could there be a shortage, particularly when there hadn't been significant changes in either the rate of consumption or the rate of production?

That's one of the troubles with statistics: they don't always give the correct answer. In this case, the real answer is found in geography and economics.

Almost all of Canada's discovered petroleum is in the West, but the principal markets are in the East. Transporting it from the source to the market – most of it over land – is costly. On the other hand, oil from the Middle East used to be so cheap it could be shipped all the way to Eastern Canada and still cost less than Canadian oil. Consequently, the regions of Canada east of the Ottawa Valley have traditionally imported their crude oil from the Middle East and Venezuela. Ontario refiners may have preferred to use the less-costly imported oil, but have been prevented from doing so since 1961, when the Federal Government decided to reserve the Canadian market west of the Ottawa Valley for Canadian oil in order to stimulate the growth of Western Canadian production. Indeed, successive governments actively promoted export sales to the U.S. to provide further increases in the demand for Canadian oil. Demand grew slowly and it was not until 1973 that the industry came close to being able to sell what it was capable of producing. Now the industry is finally producing at near-capacity rates and Canada is exporting what's left over after meeting its own needs in the market areas served by Canadian oil. On balance, the country is self-sufficient.

However, it's one thing to be self-sufficient on balance; it's another thing to be physically self-sufficient. Physical self-sufficiency in the oil industry is a combination of several factors – crude oil supply, transportation facilities to move the crude, refineries and distribution systems. Canada had sufficient crude oil supply, but the transportation facilities – mainly pipelines – stretched only to Port Credit in the east and Vancouver in the west. Refining capacity in Ontario was so tight that concern for last winter's product supply for that province was being expressed as early as June, 1973.

When some of the Arabian nations began reducing production last fall and imported refined products became scarce, a situation that had been tight loomed as potentially critical.

Faced with the prospect of a winter without enough fuel oil for several million Canadians, the federal government prudently purchased 1.5 million barrels of heating oil on the inflated international market. It never had to be used.

And so ended the strangest non-emergency that Canadians have probably ever not had to face. Dutch motorists had to make trips into Germany to fill their tanks, Americans spent hours seeking stations with some gas to sell, the Italian government imposed early closing hours on nightclubs and theatres, and British cars waited for gasoline in two-block-long lineups that backed up to Buckingham Palace, but Canadians were making out just fine, thank you. The national crisis, which had loomed so large in November, fizzled into oblivion by spring.

What happened to the crisis?

It was overcome by a combination of good luck and good management. For instance, the one thing that no one could count on was a normal winter. Long-range temperature forecasting is a shaky thing at best, but last fall, when it first became apparent that there could be some shortages, all the signs pointed towards a colder-than-normal winter. So, when the winter turned out to be no worse than usual, fuel oil needs were much lower than anticipated.

There was more to the story than just good weather. Many Canadians took conservation to heart and began driving at lower speeds. Thermostats were set a bit lower than normal, too, and a little petroleum saved here and there by careful individual use added up to a considerable national saving over the winter.

Also, from the moment the potential crisis became apparent, oil companies began building up a backlog of supplies. To avoid regional shortages, contingency plans were made for moving supplies from areas with surpluses.

To offset the shortage of imported crude and refined products in the Atlantic and Quebec regions, Canadian crude oil was supplied by tanker through the Great Lakes and, after freeze-up, through the Panama Canal. This movement is still continuing through the Great Lakes.

And, in the final analysis, more than a little luck was involved. All winter long, refineries were operated at the limits of their capacities – without a single major breakdown. Just one failure in a major refinery could have been critical; it didn't happen.

The immediate danger passed with the coming of spring and everyone began to breathe easier. Middle Eastern crude supplies returned closer to normal in March. But in general the Middle East remains a politically volatile area, and nobody can be sure it wants to meet the demands made on its pe-

Imperial Oil Limited

Imperial Oil's drilling rig at Natagnak probes for oil six miles from Atkinson Point, N.W.T.

troleum supplies, even in times of peace. So, in order to reduce dependence on foreign oil, in late 1973 the Federal Government proposed that the Interprovincial pipeline be extended to Montreal. This will be a costly measure, justifiable only for the short-term security it provides. Production from Canada's existing western fields won't be able to supply the Montreal market after the early 1980's and the line would not be fully used after that time, unless or until crude oil is available from Canada's northwest frontiers, the tar sands, and other heavy crude oil sources.

More refineries are under construction and some of this additional refining capacity will be ready this year. There may be some necessity again next winter to push the Eastern Canadian refineries to the limits of their capacity but even this necessity will be eased when all the new capacity is on stream in 1975. All the developments, taken together, indicate a less troublesome winter this year than last – barring unforeseen difficulties such as another Middle Eastern embargo combined with bitter winter temperatures.

Which brings us to the end of the good news.

The bad news starts where the good news leaves off – in the existing oil fields of the West. Peak production has almost been reached in the Western fields and will begin to decline soon. The present fields will be unable to meet demand in the early 1980's. They will continue to produce oil for many years after that, but in gradually decreasing amounts.

Estimates by the Geological Survey of Canada suggest that there is an even chance that about 80 billion barrels of oil remain to be discovered in Canada (about six times as much oil as has been found so far in Alberta) but this new oil will be more expensive to find and produce than the Western oil.

One reason is the problem of location. Oil fields developed in the past were located in more-accessible regions; most of Canada's undiscovered reserves of oil and gas are believed to be in fields in the less-accessible frontier regions. Indeed, technology has not yet been developed to permit the industry to explore all areas of potential by drilling, much less to recover the oil. Consequently, a tremendous amount of research will be required even before exploration drilling can begin.

Because of the enormous expense involved, the discoveries must be correspondingly large, at least in the beginning. Small pools, particularly in the frontier regions, cannot be developed economically on their own.

The Geological Survey of Canada estimates there are about 4 billion barrels of oil and 44 trillion cubic feet of natural gas

Syncrude Canada Ltd. will spend some $1 billion on a plant to recover oil from the Athabasca Tar Sands. Total reserves in place there are estimated at more than 600 billion barrels

Between 1971 and 1974, Imperial spent over $25 million to improve the Sarnia refinery's efficiency

still to be discovered in the Western Canadian basin but, if it is found, it will almost surely be found in small, scattered pools and for these to be developed, the producer's share of the rewards will have to be sufficient to offset the higher costs per barrel of low-volume production.

And the 80 billion barrels of potential reserves is just that – potential. A barrel of petroleum doesn't count for much until it's discovered, developed, produced and transported to market.

Potential reserves are assessed by earth scientists on the basis of the estimated geological characteristics of various regions. Because petroleum was created under special geological conditions millions of years ago, geologists are able to estimate the petroleum potential of a region by investigating its rock formations to see if they were laid down under possible petroleum-creating conditions.

Geologists can estimate what total amounts might be found, but they can't tell specifically where the pools are located or the amount of oil that is in each pool. That's the job of the petroleum explorer. And his fortunes depend entirely on whether the area he investigates contains an oil-bearing pool that is economic to produce.

Consequently, the petroleum exploration business is highly speculative. For the few explorers who discover large pools, the rewards can be quite high (and lead to the frequent charge that the profitability of the petroleum industry is excessive). But against these very profitable ventures must be applied the costs of the unsuccessful exploration attempts. For example, in the frontier areas, only one well in eight has discovered significant shows of oil or gas. And risks are not confined to exploration alone. Economic uncertainties – inflation, for example – can be as risky as oil wildcatting, and politically-motivated changes in regulations can turn a potential success into a flop.

The Canadian experience demonstrates the risks of the petroleum business. A very few companies operating in Canada have been significantly successful in exploration. Many more have made only modest returns. And some are still in the red from a cash standpoint. The expectation of being more successful than the others is what keeps exploration going.

Oil company profits have been the principal source of the money needed for exploration and development in the past – last year, for example, Imperial Oil reinvested $124 million of its earnings of $228 million in exploration and development. Continued exploration is essential if Canada's energy needs

George Hunter

The Costs of Energy

The cheapest producible energy in the world today is the oil from the vast pools of the Middle East. In those pools, wells produce at rates 50 to 100 times as great as the Canadian average. With wells so prolific, fewer have to be drilled. For this and other reasons, the investment in facilities needed to produce a barrel of oil per day is very low, about $300.

Canadian oil costs more to produce than that, unfortunately. In the existing fields of the Prairies, it needs between $2,000 and $3,000 of capital investment to add another barrel-per-day of oil production. New oil from the Prairies, because it will come from small fields that are widely scattered, will require investments of between $5,000 and $6,000 per additional daily barrel. Oil from the frontiers – the Arctic and the Atlantic – will require investments of from $5,000 to $8,000. Oil from the tar sands and heavy-oil deposits of Alberta will require investments of $8,000 to $10,000 per daily barrel of production. Energy from gasified coal will require investments of $10,000 to $12,000 per daily barrel equivalent. And from hydro-electric or nuclear sources, the investment required will be the equivalent of $12,000 to $25,000 per daily barrel.

The implication is clear; the days of low-cost energy are gone.

are to be supplied from Canadian sources. The money to pay for these programs will have to come from the earnings of the oil companies or from outside investors. In either case, the companies' performance must be such that they can either generate or attract the money they will need. Therefore, a good earnings record is essential if exploration is to continue.

In the case of the tar sands, where vast amounts of recoverable oil are known to exist, large costs are required for extraction plants. For the tar sands to be developed, the revenues of the developing companies will have to provide an acceptable return on the investment required, and still leave the price of tar-sands crude at a level that is competitive with alternative supplies of energy forms.

Even in currently-producing fields, costs are increasing. As reservoir pressures decline and the amounts of water produced with the oil increase, for example, facilities must be installed to increase the pressure and to remove and safely dispose of produced water.

And so it goes: higher costs and greater risks combine to require proportionately larger revenues if the new petroleum supplies Canada needs so urgently are to be found, developed and brought into production.

For these reasons, the days of cheap energy are gone. But Canadians can take comfort in the knowledge that, given suitable policies, we can be sure of having the petroleum we need. □

When Strathcona, Imperial's new Alberta refinery, is finished early in 1975, it will process 140,000 barrels of crude oil daily

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Designer/Bill Williamson
Editorial Production/Cathy Hayward
Cover/Horst Ehricht: Sailboats in Toronto harbor

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Imperial Oil Review

1974 NUMBER 5

in review

Patrick Conlon is still a man to trust – he isn't over 30 yet. No stranger to pop music, Conlon spent three years reviewing it for the record magazine RPM, and for two years on CBC he was the only music critic in Canada who acknowledged it as a valid music form. Conlon lives in a wildly eclectic Toronto apartment, replete with potted plants, antique clocks, early pocketwatches and the best hi-fi equipment he can find. He plays the autoharp and, while he used to be an actor, prefers writing, because 'I enjoy the control a writer has over his creative product.' His article on Canadian pop music on page four is his second for the Review. In the last issue he reported on the subject of early Canadian clocks.

Words have always played a large part in the life of Larry Collins, who wrote 'Birds of a Feather' on page 20. He taught English in a Saskatchewan high school, was a reporter with the Edmonton Journal, Canadian Press, the Ottawa Citizen, the Toronto Telegram and the Toronto Star, before taking the jump into freelance writing two years ago.

A confirmed city dweller, he lives in one of Toronto's leafiest areas, claims he can't tell a pine from a maple, and cuts his steeply-graded lawn by letting the lawnmower run down the incline and then hauling it back with a rope. Curious people, these writers.

By the age of 11, Frank de Matteis was already deeply involved in the field of natural history generally and birds particularly. When he was 17 he had a show at Toronto's Pollock Gallery, when 25 of his paintings were sold in less than an hour – the same thing happened three years later.

De Matteis doesn't drink, doesn't smoke, spends hours cycling, and during the fall migrations is in downtown Toronto by 5:30 a.m. gathering the grim harvest of wild birds that break their necks against office buildings along their route. 'It isn't sentiment,' says Frank. 'I freeze the bodies and then can study the muscle development, the conformation of the feathers, and anything else that helps me know the bird.' His work appears in this issue.

Kenneth Bagnell started his writing career as a sports writer in the 50s for the Sackville (N.B.) Tribune Post. He was paid 10 cents an inch for his copy. But better things were in store for Bagnell, and he became the managing editor of the United Church Observer for three years, during which time he travelled through India, Russia and the Middle East, writing for Canadian and American magazines, also writing and narrating a number of TV documentaries for the CBC.

He was editor of the Globe Magazine in the early 70s and, later, a daily columnist for the Globe and Mail. During 1973 he was host of a CBC TV show in Halifax, N.S.

And with the next issue, he becomes the new editor of Imperial Oil Review. □

Patrick Conlon

Kenneth Bagnell

Larry Collins

Frank de Matteis

contents

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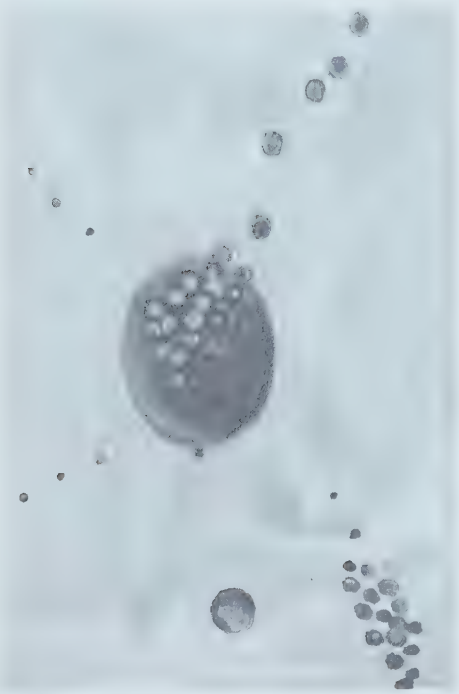


Anne Murray just signed the highest-paying contract awarded to any Canadian recording star

The Sweet Taste of Canadian Pop

Despite a few discordant notes, Canadians are making happily successful music

by Patrick Conlon

Quick, now. Who were Canada's favorite pop recording stars in 1964? The Beatles, the Rolling Stones, Brenda Lee and the Supremes? Right, but not one of them was Canadian.

Canada really didn't have pop music stars 10 years ago. Canadians engaged in pop music at the time either resigned themselves to limited careers here or left for the United States.

But in 1965 a little-known Winnipeg group, Chad Allan and the Expressions, recorded a song titled Shakin' All Over and released it in the United States. It sold a million in North America and marked the first time a Canadian group had a genuine hit in the tough American market. Although their next hit – These Eyes – didn't appear until 1969, the group is now rich and famous as the Guess Who. And while the Guess Who has proven that Canadian performers can sell their records internationally, they also proved that it's possible to remain Canadian and be successful at the same time. They call Winnipeg home, even though they're in demand as far away as New Zealand and Japan.

In the decade since 1964, Canada has developed a recording industry with stars of its own. People in the business generally agree that two recent events helped accelerate it.

The first was Canada's centennial. That event provided an occasion to take a good look at the country's artistic assets. With its emphasis on the Canadian imagination, Expo 67 was a showcase both for the world and for Canada itself. Canadian songwriters, singers and musicians were given their first big chance at Expo to develop national audiences.

The second major boost to Canadian talent was a controversial decision by the Canadian Radio-Television Commission, broadcasting's governing agency.

In January, 1971, the commission ruled that 30 percent of all music played on Canadian AM radio stations must be Canadian in one of four defined ways: the words must be written by a Canadian, the music must be composed by a Canadian, the song must be performed or produced in Canada, or its principal performer must be a Canadian. In 1972, the regulation was tightened: a record had to meet two of the four criteria to be considered Canadian content.

The CRTC declared at the time that it was directly concerned with stimulating the growth of Canadian talent. Supporters welcomed the legislation because it compelled radio stations to search for Canadian records to meet the CRTC standards. That meant the record companies themselves were required to record and supply Canadian talent, and if they didn't have any Canadian performers in their catalogues they had to go out and find them. The result was a sudden emergence of new Canadian talent.

The ruling has had its critics, particularly in recent months after the CRTC announced its intention to review the terms of the legislation and possibly strengthen them. People like Leonard Rambeau, Anne Murray's manager, are urging caution. 'I'm bothered,' says Rambeau, 'by all the success the Canadian-content rule has generated. There's been a big rush to get into the business because it has been proven you can make a decent living in Canadian music. Thanks to the CRTC, the record companies are opening their doors to Canadian performers. I'd like to see the CRTC concentrate now on improving the quality of Canadian music rather than increasing its quantity. But, by God, the boost sure came at the right time!'

It certainly did for his client, Anne Murray, who went from relative obscurity in 1971 to overnight fame with Snowbird. Two million North Americans bought that record. There probably aren't many Canadians who haven't heard the song, and Miss Murray acknowledges that the CRTC decision was directly responsible for its popularity in Canada. She has since become an international superstar but, like the Guess Who, she lives in Canada. She recently renewed her agreement with Capitol Records and although the contract figures haven't been released, Rambeau claims the sum is the highest ever paid to any Canadian recording star.

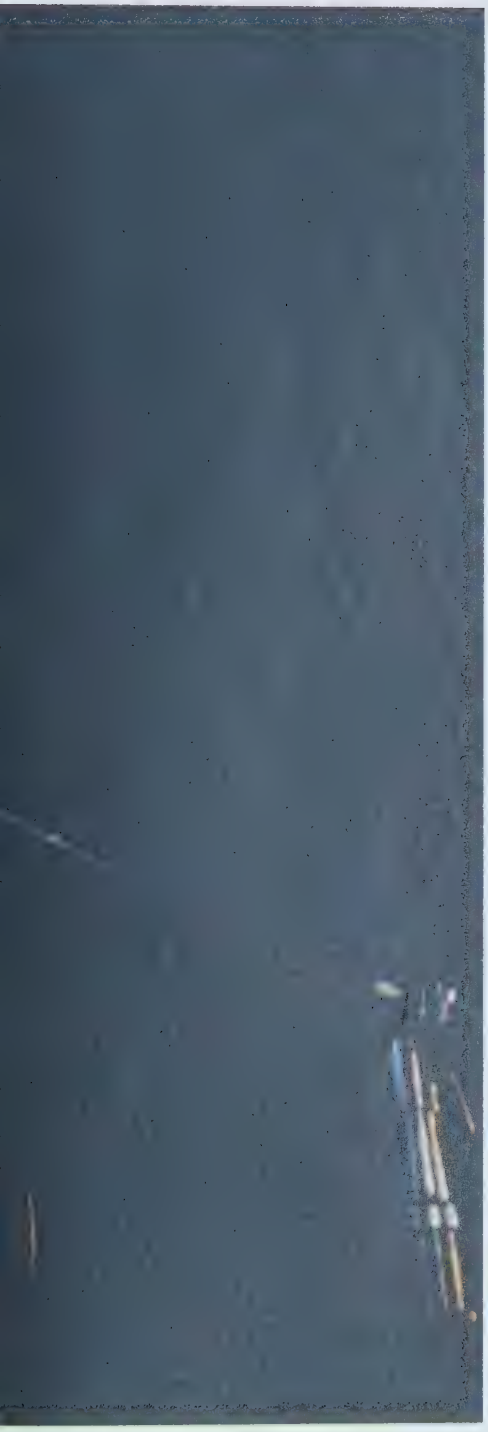
Gordon Lightfoot, Canada's best-known folksinger, has had many hit records in the U.S.

Anne Murray, as well as other stars like Gordon Lightfoot and such groups as Crowbar and Lighthouse, now live in Toronto. That city is the Canadian centre for music production – most of the studios and record companies are based there – but regional performing communities are thriving in other parts of the country.

In Quebec, for instance, recording stars live comfortably off sales of records in that province alone. Names like Robert Charlebois, Richard and Marie Seguin and Renée Claude may not yet be familiar to the rest of Canada but they're big stars in Quebec. Maritimers have their own stars, notably Stompin' Tom Connors and John Allan Cameron, who have earned national recognition. For years, one of CBC television's most popular shows was Don Messer's Jubilee, which originated from Halifax. The Prairies have produced some important groups, like the Guess Who, Bachman-Turner Overdrive and the Stampeders. Vancouver is the home of Terry Jacks, whose recording of Jacques Brel's Seasons In The Sun sold more than seven million copies in 1973. Jacks leads a system of west coast stars, including Valdy and Skylark, and he started his own record company recently.

If the nation's cash registers tell the truth, all this musical activity adds up to an exciting future for Canadian music.

According to the Canadian Recording Industry Association, which represents all the record labels, there were more



WFA Phot

Quebec has a distinctive music scene, and Ginette Reno is one of the stars

than twenty-nine million Canadian records sold in Canada in 1973. That's an increase of two million over the previous year. The industry reported total earnings in 1973 of nearly $50 million.

One of Canadian music's most vociferous supporters is Sam Sniderman, who owns 30 record stores across the country. Sniderman, who claims to sell 10 percent of all the records bought in Canada annually, seeks opportunities to speak out in favor of anything that will encourage Canadian talent. 'I used to feel like I was beating my head against a stone wall,' says Sniderman, 'but now Canadians are actually supporting their own talent by buying their records. Now, my wife and I believe we could open a store tomorrow stocked with nothing but Canadian records – and make a good living at it. Five years ago, I would have had trouble paying the hydro bill.'

Sniderman is particularly enthusiastic about French-Canadian music and he'd like to see its popularity increase outside of Quebec. He maintains a large section devoted exclusively to French-Canadian performers in his downtown Toronto store. 'Attitudes are changing,' he claims. 'Most English Canadians have been traditionally intimidated by French-Canadian music because they didn't understand the language. But my English-speaking customers are finally beginning to realize they've been ignoring some very talented people. It may sound corny, but music really does cross borders that are built by differ-

Pianist Burton Cummings leads the Guess Who, Canada's most famous rock group

ences. I've seen it happen. And I'm now selling more French-Canadian records than I ever have.'

Sniderman's enthusiasm for Canadian pop music is shared by two students at Toronto's York University, Lewis Markowitz and Claude Vickery. Using the facilities of Radio York, they interviewed 10 French- and English-speaking Canadian performers and blended the interviews with music into a five-album set of records for distribution to a thousand selected radio stations in North America. They call the project Concert Canadien, and it represents an effort to acquaint audiences with talented Canadian performers who are not considered big international stars. The project is financed mainly by Imperial Oil and Famous Players Limited, with assistance from the Canada Council, The Royal Bank of Canada and Xerox of Canada Limited.

There's one discordant note that mars the happy music Canadians are making at the moment – and it's struck by the fact that the industry is largely foreign-owned.

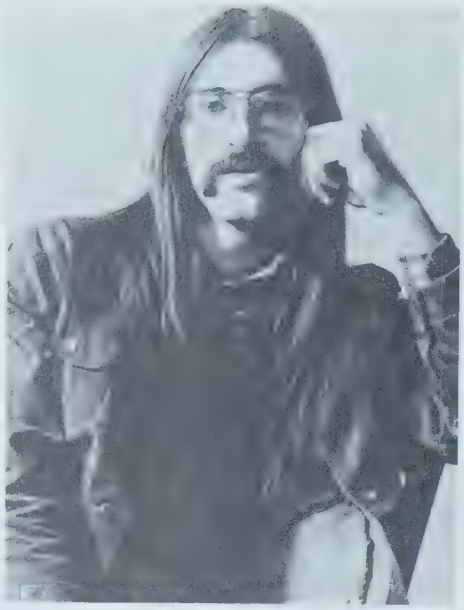
The issue of foreign ownership, while not peculiar to Canadian music, has polarized the industry. No one is probably more sensitive to the fact than Walt Grealis, an ex-Mountie who founded and edits RPM, the Canadian music industry's most influential trade journal. 'We didn't need American money to start a music industry here,' says Grealis. 'We just needed a little bit of American know-how.' Sniderman echoes Grealis' sentiments: 'I sometimes think we don't have a real Canadian music industry. We have to please too many head offices that are outside the country.'

BIC Photo

Lighthouse was the first Canadian group to add strings and brass to a rock ensemble

John Rowlands

Montreal-based rock singer Patsey Gallant has toured Europe



Capitol Records

Bill King is a regular singer on CBC's Music Machine show

BIC Photo

Formerly of the Poppy Family, Susan Jacks is on her own now

Robert Charlebois is known inside and outside Quebec as 'Superfrog'

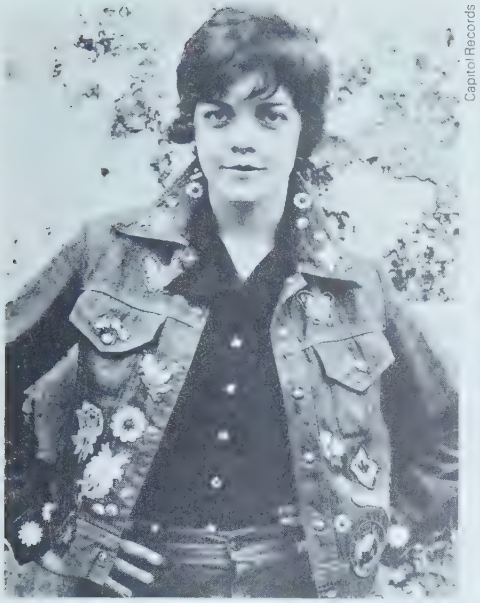
Ross Reynolds, president of the Canadian Recording Industry Association, isn't as unhappy with the situation. He also heads GRT of Canada Ltd., an American-owned record company with a list of Canadian stars who were signed to GRT when they were largely unknown. A former management consultant, Reynolds was hired by GRT to supervise its transition from a small tape-duplicating service to a major record label.

Reynolds believes that Canadian music needed outside investment to get on its feet: 'The seed money, the high-risk dollars, just haven't historically come from within Canada. But, mind you, there are isolated examples of independent Canadian producers – like Terry Jacks, for instance – who've taken successful risks.'

Still, Reynolds insists that all Canadian records now have to meet international standards to sell outside the country. 'Naturally, I'm in touch with people in other countries,' he says, 'and one of the major complaints has been that Canadian records are inferior. Most times that translates into dollars invested in production.' Reynolds believes it's a matter of economic reality. He knows his own record label can summon financial resources denied most independent Canadian producers and he states that his company's goal is to provide Canadian records that are good enough to compete in the international market.

Walt Grealis and Sam Sniderman agree with Reynolds that the American contribution to Canadian talent development has been substantial. In a recent editorial in his magazine, Grealis made a direct bid for peace, and both sides in the ownership issue now seem anxious to tackle problems that are more immediate deterrents to growth.

The CRIA, for instance, is currently at war with bootleggers who transfer music from disc to tape and then sell the tapes at prices much lower than the records. It's an illegal practice that, Reynolds estimates, took $5 million out of the industry's pockets in 1973. The Copyright Act is scheduled for revision and, while Reynolds believes it's reasonably protective, he says it contains some alarming anachronisms. 'The Act dates from the days of the old 78's,' he says, 'and it bars anyone from reproducing either side of a record without permission. Well, when the law was written there was only one song per side. Now, of course, there are five or six songs on each side of an album – and that means a lot more people are affected when someone steals them.' Many albums include contributions from dozens of people – singers, musicians, writers – and most of them are entitled to payment each time a record is sold or played. In addition, Reynolds would like to see much stiffer fines and penalties imposed on offenders.



Capitol Records

Young Shirley Eikhard plays piano and sings her own compositions

John Rowland

Randy Bachman is the heavy-sounding guitarist of Bachman-Turner Overdrive

BIC Photo

In Quebec, Renée Claude is one of the most popular singers

Despite what often appears to be a lot of bickering, there's one night in the year when the Canadian music business makes sweet harmony.

Every March, Walt Grealis and RPM magazine host the Juno Awards, an event honoring Canadian talent for achievement in a variety of categories. Only RPM subscribers are eligible to vote.

Grealis inaugurated the awards night in 1964 and 30 people attended; last March's ceremony drew 1,500 spectators and participants, a glittering cross-section of the music business. The Juno Awards were named after the Greek goddess of marriage to symbolize recorded music's union of art and technology and it's generally acknowledged within the industry that Grealis' awards night has given the business a glamorous image that it formerly lacked. Grealis has been invited by one television network to negotiate for national, live coverage of the event.

But what of the future of Canadian music? Grealis is hopeful that more independent producers will feel confident enough to strike out on their own: 'These are the people who are now going to build the industry. At the moment there are only a few recording companies wholly owned by Canadians. But one of them made $250,000 last year – and that's a pretty good beginning!' □

When he's not soloing, Neil Young tours with Crosby, Stills, Nash and Young

WEA Photo

THE REAL ENERGY CRISIS

Production from existing Canadian fields will start to decline sooner than expected, and we must weather a period as an oil-short nation

Recent calculations have uncovered some sobering facts about Canada's energy outlook: Canadian oil production could decline sooner than anticipated. By the end of 1977, Canada may be consuming more oil than it can produce.

Canada now produces about as much oil as it consumes – two million barrels a day. Data accumulated to early 1973 indicated that production would not drop below that point until the end of the decade.

But, says R. G. Reid, president of Imperial Oil Limited: 'Those forecasts did not include information on the performance of fields operating at peak rates, which has been the case over the last year-and-a-half. With these new data, the outlook is more sobering than before – we expect production will decline within three years.'

The news does not necessarily mean a shortage. However, if the forecasts are close to the mark – and Reid emphasized that this is the best one can expect in a situation with so many variables – it does mean we will have to import more foreign supplies.

Lack of net self-sufficiency in petroleum is not unusual. It is only in the last four years that Canada has been self-sufficient on balance. But with foreign oil at its present price level, the cost of importing increased supplies could have severe consequences for our foreign exchange position. Moreover, oil is now an instrument of diplomacy. Its availability as well as its price is determined by the politics of the producing states. Increased dependence on offshore oil is a source of concern.

The coming decline in Canadian oil production is a different situation than the one we faced last winter. As the Imperial Oil Review pointed out (The Energy Crisis That Wasn't – No. 4, 1974), Canadians avoided an oil shortage then through a combination of public cooperation, good management and good luck.

But it might have been better if energy supply had been a little bit tighter last winter, and Canadians understood more clearly that energy is becoming more and more precious.

'Last winter's supply problem was evidently looked on as a passing aberration by most Canadians,' says Dick Reid. 'Instead of continuing to be conscious of the need to conserve energy, we appear to have gone back to using it at close to our traditional rate. Canadians must learn to treat their petroleum supply as an increasingly precious commodity, and learn to use it more prudently.'

For 25 years, Canada has enjoyed an abundant supply of cheap energy. Its use has been promoted, and consumption has increased by five percent per year. But the days of cheap and abundant energy are over.

The solution to Canada's energy problem is simple enough, but certainly not easy: we must combine a more ju-

dicious use of petroleum with an intensified drive for new sources of economic supply. The sources are there, but they are not as low-cost or as easily available as present supply sources. Perhaps the biggest source is the Athabasca tar sands. One tar-sands plant, built by Great Canadian Oil Sands Limited, came on stream in 1967 and now produces more than 50,000 barrels per day. Syncrude Canada Limited has a plant now being built, which is scheduled to start up in 1977. It will probably be three years later before it reaches peak capacity of 125,000 barrels per day. Cost of the plant and associated facilities will be more than a billion dollars.

However, probably not more than one such plant can be built every two years. Some sources say the 'lead time' for large-scale production from the tar sands may be 20 years. Even if technology improves rapidly, it will be the late 1980s before significant amounts of oil can be recovered.

Canada's only real hope for achieving petroleum security by the late 1980s lies in finding and developing more sources of conventional, free-flowing oil. But almost all the undiscovered oil is in frontier territory. The Geological Survey of Canada estimates there are 78 billion barrels of oil in the Arctic and the Atlantic coast regions, compared to only 16 billion barrels found so far in Canada. Finding and developing that oil is going to be a time-consuming and expensive search. Imperial has already spent more than $130 million looking for oil and gas in the Arctic alone.

The entire petroleum industry could spend more than $50 billion exploring for, developing and transporting oil and gas between now and 1985.

Supply, of course, is only one side of the energy equation; the other is demand. If our annual consumption increase should drop by one percent – from five percent to four percent – it would mean a saving of about 125,000 barrels per day in 1980. This is greater than the production from any single field in Canada today. Even at this reduced rate of demand, by 1983 it is likely that Canadian production will be able to supply only the areas west of the Ottawa Valley.

By 1983 or 1984 we could be on the wrong side of the foreign-exchange equation, in terms of crude oil purchases, by several billion dollars, says Dick Reid.

Nevertheless, there is a brighter side to the energy picture. If economic incentives exist, some frontier oil could start moving to market by the early 1980s, and Canada would be self-sufficient again by the middle of that decade and a net exporter by the end of it.

But that still leaves the next 10 years. How will we tide ourselves over? The answer to that is a double-barrelled one: a careful use of our own resources, and increased imports of foreign oil.

Some would stop all exports immediately. That would delay decline in peak production for three or four years. 'Any time extension could be important,' Dick Reid says, 'but you have to balance it against the other factors – the effects on Canada's foreign exchange, on overall trading relations with the United States, on the income of the producing provinces, on their oil-service industries, and on the amount of cash that exports make available for future energy developments.'

Whatever is done, the growth in fuel consumption will have to be reduced. The trouble is, surveys indicate that most people don't feel they face a serious situation. The federal government plans a major advertising campaign this fall urging Canadians to save energy.

What might be more effective, says Reid, is letting the price of petroleum find its proper market value instead of being regulated by government.

Lest a proposal for letting petroleum find its market value be seen as an oil man's desire to print money, Dick Reid pointed out that, under existing tax and royalty laws, the federal and provincial governments are the principal beneficiaries of any price increases. The oil industry would get additional income from higher prices, but it needs this income badly for the major investments it must make to find and develop supplies in Canada.

A price increase could work some hardship – to some there could be a drop in the standard of living. The competitive ability of some businesses might be affected. But where real hardship is evident, subsidies could be provided.

The idea of letting the marketplace allocate goods and services is not fashionable in government today. Yet, it is the most impartial mechanism for allocation of demand and development of supply.

If new sources of energy are to be developed, the petroleum industry needs not only a realistic price, but a realistic tax and royalty policy. The billions of dollars needed will be invested only if the petroleum industry is in good financial health, and in recognition of the risks and the long time that passes before investments make a return. Today, for example, more than 25 years after Leduc was discovered in Alberta, the exploration and production aspects of the oil industry have still spent about $1.4 billion more than they have received in revenue. During the same period, the industry as a whole paid more than $6 billion to government in taxes, royalties, land bonuses, rentals, etc.

Government must create a climate that will encourage investment in the petroleum industry if Canadians are to develop their petroleum resources. Investor confidence is the key to this development, and it is critically dependent on returns from past investments. If potential investors believe future returns will be decimated by legislation, they will not take the risk.

Traditionally, Canada has had a venture-oriented policy on resource development. That is, the returns have justified the risks, and Canada is the only industrialized country in the non-communist world that produces more oil than it consumes. We will lose that position in a few years; if we are to regain it, public policy must continue to be venture-oriented.

Right now, says Dick Reid, petroleum developers are proceeding on faith that such a policy will prevail. However, because of uncertain conditions, there has already been a drain of expertise and equipment out of the country.

'Unless public policies on petroleum development become more realistic, that drain could become a hemorrhage,' Reid says.

'Throughout most of our history, most of our major public policies have been designed to bind together and strengthen our nation,' he says. 'I am convinced that at this crucial stage of our economic development, public policies will evolve that will continue to serve the best interests of our country.'

Our energy outlook is cause for concern. But there is no need yet to flee to the tropics. □

THE HELPFUL HUNGRY MICROBE

There are organisms that can live on crude oil. Putting their appetites to work is one way of combatting oil spills

by James Hickman

drawings by Eric Aldwinkle

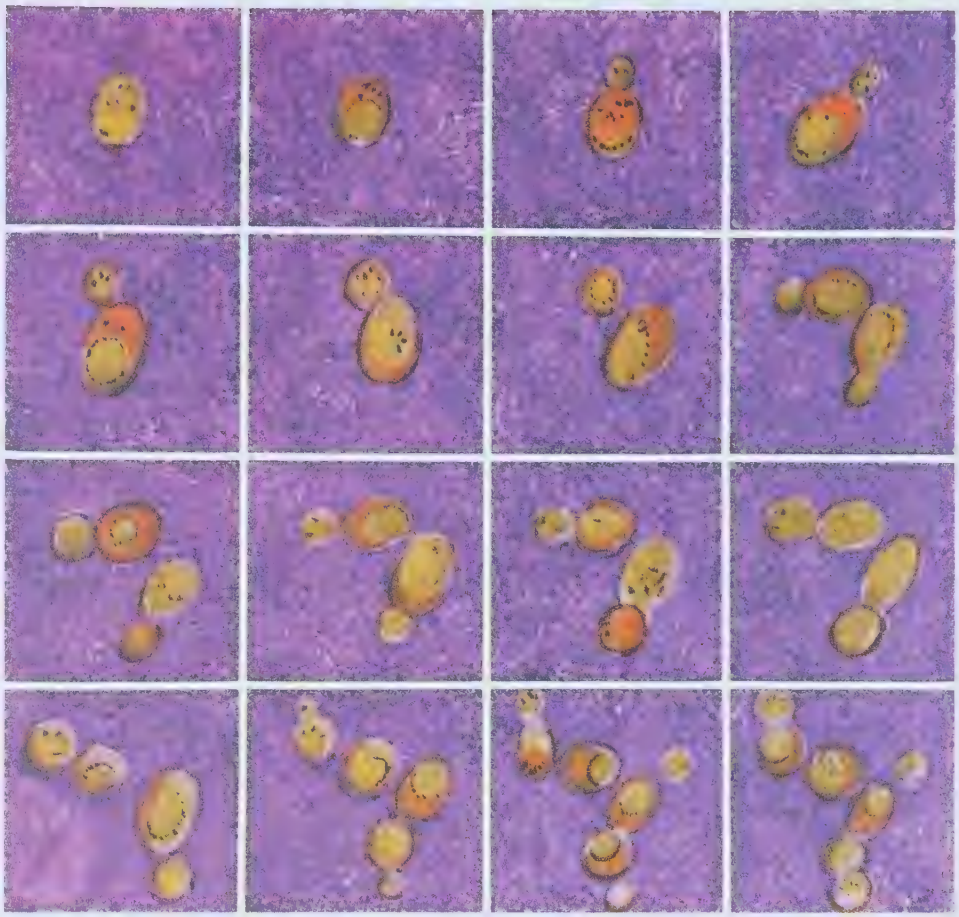
A group of tiny organisms, invisible unless magnified hundreds of times, may turn out to be among man's best friends. The earth teems with them. As many as 100 million may inhabit one gram of soil. They are everywhere except in parts of some deserts and the coldest polar regions. They exist on the ocean floor and thousands of feet underground.

These organisms are called microbes and they are alike in that they are all one-celled. They absorb food through the cell wall and eliminate wastes the same way.

While all of them live on organic material in the earth, their diets vary – some eat starches, some eat sugar. Nature seems to have worked out a balance between them.

'In the same way that some fields grow wheat, others corn, and still others fruit,

Under optimum conditions, bacteria can multiply simply by dividing every 15 minutes. In this drawing, a cell begins to separate



Yeasts reproduce by budding. This illustration, taken from photomicrographs, shows a budding cell at 15-minute intervals

there is a relationship among the microorganisms,' says Dr. Don Westlake, chairman of the department of microbiology at the University of Alberta in Edmonton where he and his associates are studying bacterial action. 'Some bacteria will feed off certain materials,' he points out, 'while other bacteria eat something different.'

Microbes can utilize 99 percent of the dead organic matter on the earth's surface. The remaining one percent that isn't broken down forms coal. Besides their food, they need only water, from which they get oxygen, and a reasonable temperature in order to survive.

When food is abundant, the microbe population multiplies explosively. Then, when the nutrients are consumed, some die and some go into a dormant stage until a new food source appears.

Some scientists are particularly interested these days in two kinds of microbes . . . bacteria and yeasts. While they are alike in some ways, bacteria are the smaller and busier of the two. Their single cell multiplies by a simple process of dividing, the nucleus separating into two identical parts and the cell then splitting in two. Under ideal conditions, bacteria can divide every 15 minutes.

Yeast cells are not quite so prolific. Like bacteria, they are considered to be plants, but they are a fungus type of plant. That means they multiply by growing buds or spores which create new cells. It takes a yeast cell from two to 10 hours to double itself.

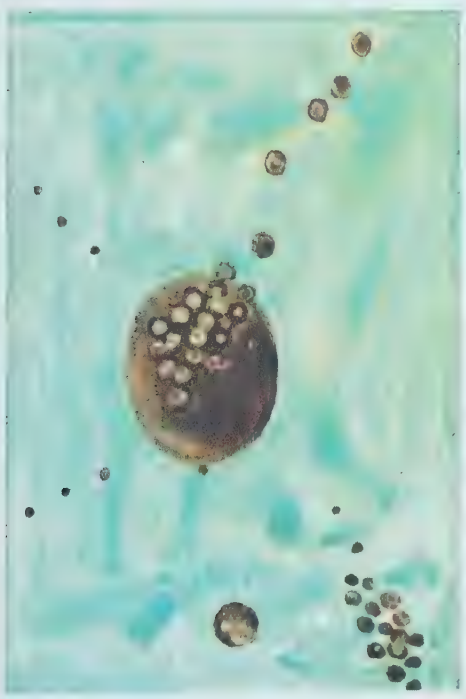
There are other significant differences as well. Bacteria prefer to live in neutral or alkaline soil whereas yeasts can survive in an acidic environment. Yeasts can live in the cold; in fact, some strains thrive at 10 Fahrenheit degrees above freezing. Most bacteria would be dormant at that temperature, and even at 50 degrees they would be moving very slowly. On the other hand, yeasts cannot tolerate a temperature much above 90 degrees while bacteria can exist at 120.

These tiny organisms are important to man in a way that is far out of proportion to their size. Like bacteria, yeasts have variable diets, but both have one taste in common – an appetite for crude oil. This is unique among living things because oil is basically a killer. Any animal that drank it would find it not only unappetizing but lethal. Crude oil is also fatal to vegetation. Yet some strains of bacteria and yeasts will gobble up oil with the gusto of a piranha eating raw meat.

Now, microbiologists have devised ways of using these minuscule organisms to combat oil spills. At the University of Alberta, others besides Westlake have been examining oil-eating bacteria. Among them are Dr. Ted Cook, professor of microbiology and soil science, and Allen Jobson, a graduate student in microbiology. Their research was funded partly by grants from Imperial Oil.

'Bacteria can be managed for man's benefit,' says Cook. 'To perform at their best, though, they must be fed. For good oil consumption, other nutrients must be added.'

Not just anything will do. For the few dozen strains of bacteria that consume oil, nitrogen and phosphorous must be added before they will do the job. That's where microbiologists like Dr. Cook come in.



Bacteria multiply on an oil droplet, absorbing oil directly through their cell walls, and eliminating waste in the same way

Dr. Ted Cook, professor of microbiology and soil science at the University of Alberta, studies oil-consuming bacteria for use in fighting spills

Photos by Chris Brunn

'Oil has enough carbon and sulfur in it for bacteria,' he says, 'but not enough nitrogen and phosphorus. Bacteria living in the soil will attack spilled oil immediately and consume all the nitrogen and phosphorus. Then the bacteria will stop reproducing and either die or go into a dormant state.'

That, of course, doesn't finish the job. The oil stops disappearing and the soil remains dark, greasy and oily-smelling. Water won't seep into it and plants won't thrive on it. It may take years for any vegetation to reappear.

To remedy this, Cook and his associates feed the microbes fertilizers, which are sources of nitrogen and phosphorus. The microorganisms start consuming oil again until the food source is depleted. Then the bacterial colony dies off or goes into a dormant state.

The effect of the bacteria is evident; the soil quality is better than before the spill. The poisonous effects of the oil have been removed.

'There is a marked difference in the soil,' says Westlake. 'It's detoxified and it looks better. Plant growth will show up much more quickly, perhaps in less than a year.'

'Of course the vegetation will die immediately,' says Cook, 'but it is remarkable how soil can bounce back if treated.'

At four locations in Alberta and the Northwest Territories, the University of Alberta researchers are studying plots of land where oil has been spilled. They rake the soil to introduce oxygen and then add fertilizers, producing ideal conditions for bacteria, which are already present in the soil. Once the fertilizers have been added and the ground raked, the bacteria can increase their population about a thousandfold.

'You can tell when bacteria are working on the oil,' says Cook. 'Carbon dioxide is given off for one thing. Also, enough heat is generated to melt a light covering of frost or snow.'

You can't see the bacteria, but you know they are there in the millions, feeding on the oil.

The number of strains of bacteria that eat oil is not known exactly. Researchers are discovering more oil-eaters all the time. Different types of oil activate different kinds of bacteria.

There is still much to be discovered about bacteria's effect on oil. What happens, for instance, when bacteria can't absorb oil? The soil may be too acidic, or the weather in a place like the Mackenzie Valley may be too cold. In such cases, yeasts may come to the rescue.

At the Alberta Research Council, Dr. Toshi Kaneda has been studying yeasts that absorb oil. His work began when the provincial government decided to try converting crude oil into a protein source for farm animals. Yeasts consume the paraffins or waxy substances present in crude, as do bacteria. Then their bodies make up a protein that is fed to chickens or hogs in some parts of Europe, including Scotland and France.

A similar stock feed was not feasible for Alberta. For one thing, Alberta crude does not have a high paraffin content. And the province has plenty of natural fodder anyway.

'The farm feed concept is unattractive for the time being,' says Kaneda, who is senior research officer and head of microbiology at the government agency.

Instead, Kaneda is investigating the prospect of cleaning up oil spills with yeasts. At 64 to 125 times the size of a bacterium, a single yeast cell can absorb

much more food. This would mean increased activity on an oil spill. Moreover, the ability of yeasts to thrive in a cold climate may make them preferable to bacteria in cleaning up an Arctic oil spill. In warmer climates bacteria, with their rapid growth, would be better oil-consumers.

To work at their best, yeasts don't have to be grown in oil as bacteria do.

'Yeasts can be grown in malt extract, glucose, or other materials and still be oil-eaters,' says Kaneda. 'We are thinking of coating dry yeast with nutrients, such as nitrogen or phosphate fertilizer, to make pellets that could be sprayed on an oil spill.'

These pellets could be stored for years and easily transported to the scene of a spill.

Yeasts do not have to be grown specially for oil consumption, though. At several Arctic points, strains that thrive in the cold and can eat oil have been found growing naturally. Where oil had been spilled near airstrips at Sachs Harbour on Banks Island in the Northwest Territories, yeast populations were feeding and growing, even though the area was barren.

At the Alberta Research Council in Edmonton, Dr. Toshi Kaneda has been observing certain strains of yeasts that are capable of eating oil

Yeasts are similar to bacteria in that both will quickly attack paraffins but are choosy about the benzenes in oil. Neither microbe absorbs benzenes easily and these are left in the soil as an asphalt residue. However, Kaneda says, this substance is not toxic and does not prevent revegetation.

No one is suggesting that bacteria and yeasts are the perfect answer to oil spills, or even that they should be stressed in lieu of other methods.

'This isn't an overnight solution,' says Westlake. 'First there should be containment and removal of most of the spill, then microbiological work may be attempted.' But it is an avenue of promising research. □

In charge of oil-eating bacteria studies at the University of Alberta, is Dr. Don Westlake, chairman of the microbiology department

LIFE AT THE LOWER DEPTHS

Geochemist Dave Milner says bacteria can exist 10,000 feet below the earth

Photos by John Colville

Thousands of feet below the surface of the earth, in places where there is total darkness and barely any moisture circulating through rock crevices, living creatures eke out an existence. These bacteria and yeasts – the only living things able to survive the earth's depths – are the same types of microbes now being put to work above the ground to combat oil spills. Indeed, they probably originated on the earth's surface and drifted down with moving water.

'The effects of bacteria are evident on oil 10,000 feet underground,' says Dave Milner, an Imperial Oil geochemist in Calgary. 'Although no one has ever seen them in their habitat, we know the microbes are down there.' That means the existence of underground microbes is known only by the evidence they leave behind.

Dr. Toshi Kaneda, who has been studying oil-consuming yeasts for the Alberta Research Council, believes yeasts occur deep under the earth. 'We have no information to prove this as yet,' he says. 'There has only been a limited amount of interest in the study of yeasts. They live on the paraffins in oil much the same way that bacteria do. Where petroleum is available to provide paraffins, there is little doubt that yeasts also exist.'

The study of bacteria and yeasts has been going on for more than 100 years. About 25 years ago, geochemists and microbiologists crossed paths. And, just a decade ago, controversial new theories about the relationship between microbes and oil-producing rock formations were published. These theories are generally accepted in most scientific quarters now. Dave Milner smiles when talking about them. 'I was very skeptical at first,' he says. 'Just 10 years ago, you would have been laughed at if you said oil had been chewed up by bugs.'

No one is laughing anymore. Many oil companies have been doing research recently into the effects of underground microorganisms on oil; Imperial has been studying the relationship since 1969. 'Even then,' Milner says, 'the theories were not fully accepted in all scientific circles.'

Of course, microbes do not thrive everywhere under the earth; three conditions must be met or they cannot survive. One is the availability of water, from which they get oxygen contained as dissolved gas or bound in salts. This water circulates underground, trickling in crevices or connected pore spaces in sandstones and limestones. Or it moves slowly through fine-grained siltstones and shales. Almost everywhere under the earth, there is enough water to support microbial populations, but other conditions must be met for them to live.

Temperature is a factor deciding whether there will be life at the lower depths or not. In most cases, the temperature increases one to two degrees for every 100 feet of depth. Since little or no life exists past the boiling point of 212 degrees Fahrenheit, and most bacteria cannot live at temperatures

Bacteria and yeasts can thrive more than half a mile below the ground. All they need is oil, and a little water

Brian Burns, a Calgary geochemist, believes microbes went underground with moving water

much above 120 degrees, a depth of 10,000 feet below the surface is about the limit for microbes. Even at that depth, bacteria strains would not be prevalent. 'About 2,000 feet underground is where most of the sub-surface microorganisms live,' says Milner.

If they have water, and it's not too hot for them, then underground microbes need just one more thing for survival – food. Any organic matter, including oil, will do. Certain paraffins – the waxy compounds in oil – are the favorite nutrient of microbes because they can be absorbed through the organisms' cell walls easily. But benzene compounds in oil cannot be eaten by microorganisms unless some other easily-absorbed nutrients like starch or sugar are mixed with them.

In some oil reservoirs, production can be increased by injecting water below the oil. But the water used must be treated first to make sure it doesn't carry microbes that could multiply in the formation, clog the rock pores and corrode the pipes. The water is pure enough to drink.

In the early 1960's, before the underground-microbes theory was accepted, oil-producers in Russia were reported to be pumping starch or sugar solution down wells that wouldn't flow easily. These nutrients combined with the oil to make a mixture that could be easily consumed by bacteria. The microbes feeding off this mixture were reported to produce carbon dioxide, which created pressure underground, causing the oil to flow more easily to the surface.

'Sometimes, partial removal of the paraffins can help a well flow at lower temperatures,' explains Milner. 'If the bacteria haven't removed too much of the wax, then the well-flow can be improved. Imperial's oil at Atkinson Point in the Arctic will flow at 60 degrees below zero – much lower than usual – because it has been partially eaten by bacteria.'

Left alone underground eating paraffins, bacteria can destroy an oil pool, leaving only a tar-like substance behind that cannot be absorbed through their cell walls. 'That's probably what happened to create heavy oils, like those found at Cold Lake,' says Brian Burns, also a geochemist with Imperial in Calgary. 'The oil was exposed to bacteria over millions of years, and what remains is what they couldn't eat.'

Of course, many oilfields remain untouched by bacteria because the conditions under the earth would not support microbial life. But where they have been present, it is not difficult to find evidence of them. 'Usually, oil is composed of 25 percent to 30 percent of those paraffins preferred by microbes,' Dave Milner says. 'If there is any less, then we know bacteria have been at it.'

Do bacteria and yeasts originate in the lower depths? Most scientists don't think so. 'They probably get washed down with moving waters,' says Brian Burns. 'If there is a food source down there in the rock, the population will grow and thrive.' □

Birds of a feather

by Larry Collins/paintings by Frank de Matteis

The last Audubon Society Christmas bird count reported some rare sights: a magnolia warbler in Halifax, half a dozen cardinals at Yarmouth following a major cardinal invasion earlier in the year, a number of purple sandpipers at Montreal, a golden plover at Long Point, Ont., two white-throated sparrows at Saskatoon, and a peregrine falcon at Calgary. Altogether, 242 species were reported – 13 more than the previous year. It was a new record.

The Christmas bird count is not an accurate scientific instrument, and good weather last fall probably kept birds in their northern homes much later than usual.

Still, there is evidence to back up what many householders think they have been seeing: despite pesticides, urbanization, swamp drainage, hunting and pollution, some of our best-loved birds are on the increase.

Consider these figures from the U.S. Fish and Wildlife Service. Robins, those harbingers of spring with the 'cheerily, cheerily, cheerily' song, are increasing five to 10 percent a year in the central U.S. and doing nicely elsewhere. The white-throated sparrow is up five to 10 percent in the eastern and central U.S. The oven bird, a warbler well-known for its 'teacher, teacher, teacher' cry, is increasing by five to 10 percent in the east and three or four percent in the central U.S.

While there are no comparable figures for Canada, the birds mentioned by U.S. sources live in our country, too. It seems unlikely the population increase

Yellowthroat
This secretive little bird is most frequently found in thickets and undergrowth along the banks of streams and rivers, although it also likes the rushes and grasses in a marsh or swamp. The yellowthroat consumes many forms of insect life including eggs, larvae, grubs and adults of moths and butterflies. The bird is a major controller in areas that suffer from gypsy moth infestations

stops at the international border.

Joe Dafo of the Ottawa Field Naturalists, a bird-watching society, says he and his colleagues think they are seeing more birds than previously, although no count has been taken.

No breed of bird has become extinct since the heath hen in 1932 and some endangered species seem to have halted their decrease in numbers.

Such birds as cardinals and blue jays are spreading to new areas and the herring gull and Savannah sparrow are increasing rapidly.

A zoologist at Mississippi State University has been quoted as saying there are probably as many birds in North America now as when the white man first arrived, although not the same species.

Dr. W. Early Godfrey, curator of ornithology at the National Museum of Natural Sciences, says the bird population is always fluctuating, with some species increasing and others diminishing.

'We can't say the bird population as a whole is increasing,' says Dr. Godfrey, 'but some of the smaller species seem to be doing quite well.'

Yet, it is only a dozen years since author Rachel Carson warned in Silent Spring that pesticides were killing birds by the thousands. Has the trend been reversed? And if so, why?

The use of DDT is now severely restricted, but if that has been a factor in the bird increase, it must have been only one of several. No doubt birds are also benefitting from the setting up of sanctuaries, the preservation of swampy areas, and the preservation of forests.

It also seems civilization is not necessarily the enemy of wildlife. Birds nest happily under culverts and eaves and feed in parks and gardens. The suburbs with their gardens, trees and shrubbery may become a haven for them, particularly if the householder is a bird-lover and puts out a little food and water. Many a chickadee may have survived a sub-zero winter night because someone provided food to heat its tiny body and a tree for shelter. Birds with full stomachs are hardy creatures.

Cities are becoming more conscious of the need for park space, to the benefit of both birds and man. Even the concrete heart of a modern city seems to be able to satisfy the needs of the house sparrow and the pigeon, undesirable as those birds may be to some people.

Certainly it is to man's advantage to help birds survive. First of all there is the aesthetic benefit. The sound of the robin is a sure message that spring is here, as is the harsh 'caw' of the crow and the melodious song of the prairie meadowlark. While birds may sing to warn others away from their territory, to attract a mate, or to call their young, they sometimes seem to sing for sheer joy. Of the evening song of the yellow-breasted chat, the celebrated Canadian naturalist Percy Algernon Taverner has written:

'. . . straight up he goes on fluttering wings – legs dangling, head raised, his whole being tense, and spasmodic with ecstasy. As he rises he pours forth a flood of musical gurgles, and whistles that drop from him in silvery cascades to the ground like sounds of fairy chimes.'

But while providing us with beauty, birds pay their way. While the robin is hopping around your lawn and entertaining you, he is also searching out bugs, insects and worms to feed himself, his mate and his young. Although he also eats some fruits, he compensates for the damage he does.

Were it not for our insectivorous song-birds, the world might be overrun by bugs. Certainly, many crops would be destroyed and our forests endangered. There is a bird to hunt nearly every kind of insect. Woodpeckers are equipped with barbed tongues to probe deep into holes for wood-boring grubs. Nighthawks can pick off flying mosquitoes – thousands of insects have been counted in one bird's stomach. Although most birds don't eat ants because of the acidic secretion, flickers do, and more than 5,000 ants have been found in the stomach of one bird. In the 19th century, clouds of grasshoppers attacked the crops of the Mormons in Utah. But gulls flocked in and ate so many of the intruders that some of the harvest was saved.

If man were to give a Bird-of-the-Year award, however, it would have to go to a warbler. Warblers constitute one of the largest bird families in North America. They are small birds but colorful, with yellow the commonest hue. While some warblers are excellent singers – the yellow-breasted chat is a warbler – most are no better than mediocre; yet they make up in persistence what they lack in talent. When they walk on the ground they exhibit prodigious energy – pirouetting,

Magnolia Warbler

This brilliantly colored warbler favors the edges and clearings of Canadian woodlands, being partial to stands of young hemlocks, balsam firs and spruce. During migration it can be seen in gardens, orchards or the shade trees of parks. The birds have been seen to feed on a species of aphid that creates deformities in spruce and fir trees. Other fare includes insects such as the spruce budworm, various plant lice, leaf beetles, weevils and leafhoppers

fluttering, turning their entire bodies this way and that, darting and springing about. And as insect exterminators they are superb.

The adult warbler eats about 40 percent of its weight in insects every day. But the baby warbler eats its full weight each day. Its stomach may be filled many times and distended grotesquely. Yet if the food supply is not constantly replenished during the day, the young bird will soon starve.

Researchers have counted the feeding rate of some birds, with astonishing results. A palm warbler has been seen catching 40 to 60 insects per minute over a four-hour period for an estimated total of 9,500 insects. A yellowthroat, feeding on aphids of a gray birch, ate 89 a minute. A yellow warbler ate 33 canker worms in just over six minutes. A chestnut-sided warbler took 22 gypsy caterpillars in 14 minutes plus some smaller tidbits. Some caterpillars are supposed to be immune to capture because of spines, hair or poisonous secretions, but the warbler seems to get them before their protection is sufficiently developed. Warblers are particularly adept at finding caterpillars that hide in rolled-up leaves.

The pioneer naturalist Dr. Elliott Coues wrote of warblers in the last century: 'They visit the orchard when the apple and pear, the peach, plum, and cherry are in bloom, seeming to revel carelessly amid the sweet-scented and delicately-tinted blossoms, but never faltering in their good work. They peer into the crevices of the bark, scrutinize each leaf, and explore the very heart of the buds to detect, drag forth and destroy these tiny creatures, singly insignificant, collectively a scourge, which prey upon the hopes of the fruit grower and which, if undisturbed, would bring his care to naught.'

Warblers assemble quickly where food is plentiful, like an air-borne police force. No bird is more deserving of protection.

While some species of birds increase in numbers, others are on the wane, including one of the warbler's natural enemies, the cowbird. The cowbird is a parasite, laying its eggs in the nests of other birds. Since the cowbird is large and has a slightly shorter hatching period than its hosts, the young intruder has an excellent chance of picking off most of the food the foster parents provide.

The house sparrow, not the most popular bird, is also decreasing. But so is the yellow warbler, an excellent friend, and the lark bunting.

This should warn us to intensify our conservation measures. Can we afford to lose even the unpopular specimens? Any bird is better than no bird at all. □

Tennessee Warbler
This warbler spends its summers in the clearings and borders of the northern coniferous forest, among the younger trees. An ideal site would include adjacent areas of shrubbery, some widely spaced larger trees, boggy ground with moss and grass, and perhaps a stream.

The Tennessee warbler can be a nuisance in vineyards because it pokes holes in the grapes to drink the juice; on the other hand, it takes a high toll of insects harmful to grapes and other orchard fruit, including leafhoppers, weevils and caterpillars

(page 26) **Northern Black-throated Blue Warbler**
Deep deciduous woods, which may include a sprinkling of evergreens such as white pine or hemlock, is the home of this species. Invariably the forest floor is dense with bushes, saplings and laurel. Much of its diet consists of destructive insects that damage trees, including tent caterpillars and locusts

(page 27) **Wilson's Warbler**
This bird nests as far north as the limit of trees from Alaska to Newfoundland and southward, in cool, damp sphagnum moss bogs. It can also be found in similar moist areas such as alder swamps or in willow thickets along streams or rivers.

Since the bird chooses to inhabit such wet areas, it also eats a great number of mosquitoes. During migration, Wilson's warblers can be seen in parks and gardens, where they can glean hordes of aphids from roses and other shrubbery


Frank de Marreis 1973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(Front cover) **Chestnut-sided Warbler**
Wherever there is a clearing in the woodland with young deciduous growth such as white birch, sugar maple, black walnut and chokecherry, along with blackberry, wild grape and huckleberry, one can find this warbler. It eats various parasitic insects including tent caterpillars, borers, plant lice and beetles living in the bark of trees.